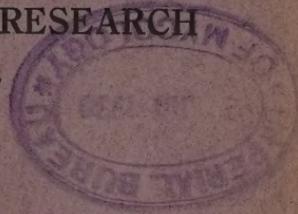


CONFERENCES

→ IMPERIAL AGRICULTURAL RESEARCH  
CONFERENCE, 1927.



REFERENCE  
ONLY

# Agricultural Research in Great Britain and Northern Ireland.



Issued by the Organising  
Committee of the Conference,  
10, Whitehall Place,  
London, S.W. 1.

*September, 1927.*



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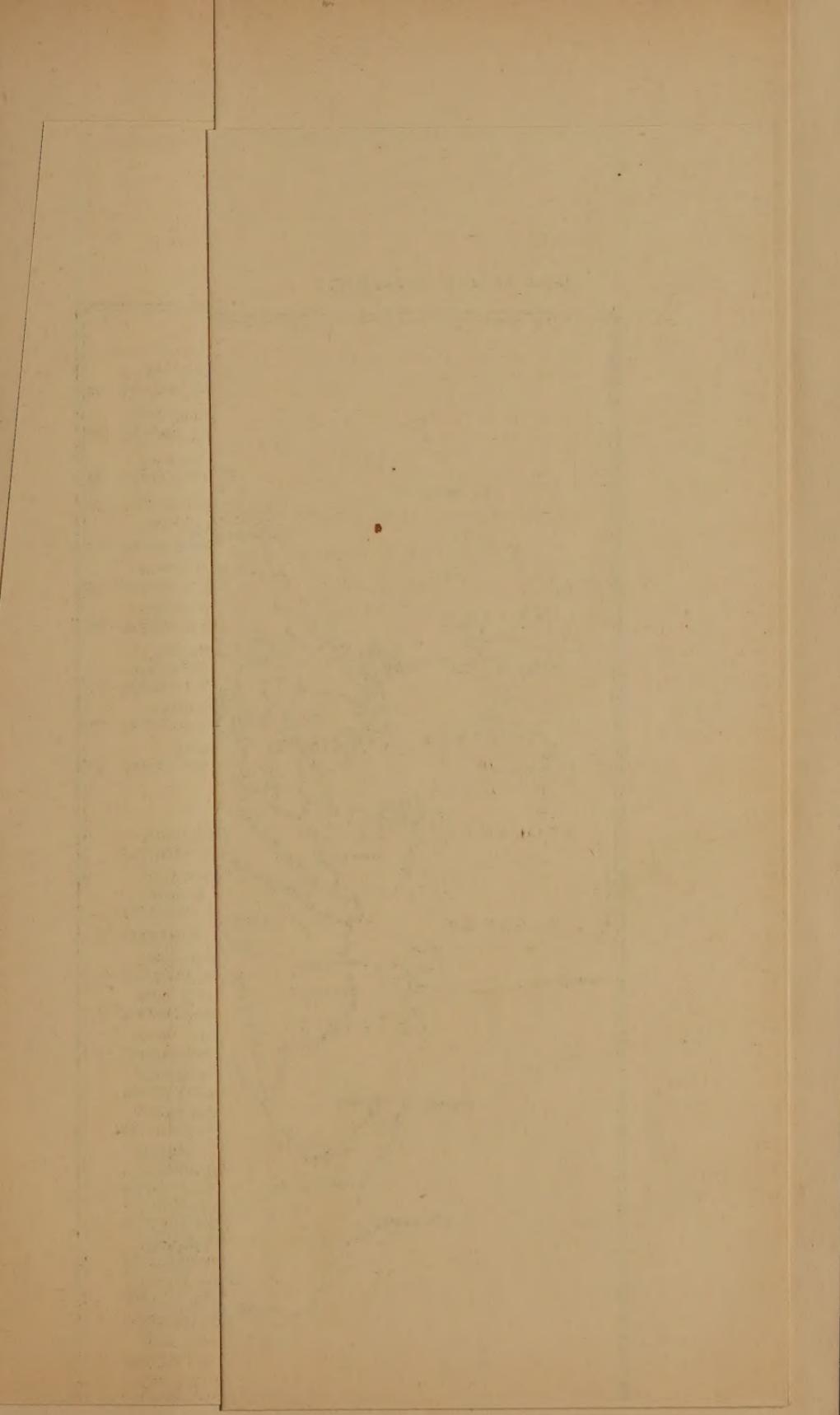
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# I.—THE ORGANISATION OF AGRICULTURAL RESEARCH AND ADVISORY WORK IN GREAT BRITAIN & NORTHERN IRELAND.

(1).—England and Wales.

The present organisation of agricultural research in England and Wales dates from the Development and Road Improvement Funds Act, 1909. That Act created the Development Fund on which agricultural research in this country has since mainly relied for its support; and it set up the Development Commission, which administers the fund. Following that Act a scheme for the organisation of agricultural research was drawn up on the following lines:

- (1) The conduct of more or less fundamental research at agricultural research institutes each dealing with a special subject or group of subjects. The whole field of agricultural research was divided up into subjects for the purpose: these will be dealt with in the account given later of each institute and its work.
- (2) The conduct of applied and local investigational work, coupled with advisory work among farmers, at provincial advisory centres. For the purpose of this part of the scheme the country was divided up into a number of provinces, a "centre" was selected (usually an agricultural department of a university or an agricultural college) for each, and a number of "advisory" (or local research) officers were stationed at each. Particulars of these provinces, their advisory centres and the officers stationed at each are given in a subsequent section dealing more fully with this work.
- (3) The conduct of research on special and definitely limited problems outside the scope of work carried out at research institutes, or supplementary to such work. It was contemplated that such work would be entrusted to university departments of agriculture, research institutes, advisory centres, agricultural colleges and other institutions and associations of a non-profit making character: but not to individuals as such.

At the outset of this scheme the field of qualified men from which the staffs of research institutes and advisory centres could be drawn was very limited; a research scholarship scheme was therefore instituted to obtain recruits by selecting graduates with first class honours in pure science and training them at research laboratories and stations both at home and abroad.

The scheme of organisation of research laid down in 1910 has proved to be admirably suited to the needs of the work and is now firmly established. The research institute scheme has proved to be flexible in character inasmuch as fresh institutes have been set up within existing subjects, or for new subjects, or for a regrouping of subjects. The advisory scheme has been extended by additions to the specialist subjects for which the local advisory officers function.

There has not, however, been any comparable expansion in the scheme for special research, and grants made under this scheme have remained at a fairly constant level; most agricultural problems require for their solution the co-operation of a team of workers in different sciences, equipment of an expensive character, and other facilities such as are usually only to be found at research institutes. Moreover, with the completion of the research institute scheme few subjects were left outside their scope.

The scheme for research scholarships has continued to be useful. As a result of expansion in the research and advisory work, the number of annual vacancies among research and advisory staffs is still considerable and the supply of qualified workers in certain subjects very small. To this scheme has been added one which affords facilities for research and advisory workers to keep abreast of methods and progress in their subjects by visiting foreign laboratories and attending international conferences.

The remarkable expansion in research and advisory work witnessed in the period 1922-1927 resulted from the provision of the "Corn Repeal Fund," i.e., the sum of £1,000,000 provided for agricultural development under the Corn Production Acts (Repeal) Act. This fund has been exhausted, but the Treasury have agreed to maintain research and advisory work at its present level and sufficient is paid into the Development Fund for the purpose.

Research institutes have, however, now commenced to obtain assistance from a further fund—the Empire Marketing Fund; much of the work at research institutes is applicable not only in this country but in various parts of the Empire. Grants have already been made from the fund to the institutes at Waltham Cross, Cambridge (Nutrition), Reading, East Malling, Long Ashton and Oxford (Economics).

#### *Status of Research Institutes and Subjects of Work.*

With one exception (the Veterinary Laboratory of the Ministry of Agriculture and Fisheries) the research institutes are in no sense Government institutions, although in some cases the initiative which has led to their creation has come from the Ministry. For the most part the research institutes are departments of a University, although in a few cases they are independent bodies. The possibility of the conduct of research under the direct control of the Ministry has been considered, but rejected on the ground that the restrictions necessary in a Government Department would adversely affect the work. On the other hand, by attaching the research institute to a University the advantages are obtained not only of the University atmosphere, which is in itself conducive to good work, but also of the informal co-operation which is assured with other workers in the fields of pure science. At the same time contact with the business of farming is readily maintained by the association of the research institute with a

university which is teaching agriculture and dealing with the farmers in its district.

The Rothamsted Experimental Station is an independent body and is the oldest agricultural research station in the country and the premier institution of the kind in the world. The East Malling Research Station and the Experimental Station at Waltham Cross are also independent bodies ; both of these owe their origin to the efforts of the growers. Examples of University institutions are provided by the Research Institutes at Cambridge, Oxford and London. At Cambridge there are five research institutions dealing with plant breeding, horticulture, animal nutrition, animal breeding and animal pathology. At Oxford there are institutes for agricultural economics and agricultural engineering. At London there is an institute for plant physiology (at the Imperial College), one for the general animal pathology (at the Royal Veterinary College), and a third for a specialised field of parasitology in relation both to animals and plants (at the London School of Hygiene). Full particulars of the research institute staffs, aims and work are given in a subsequent section.

For some subjects of research special arrangements are made, and institutions which are not properly speaking research institutes may take part. Thus the research work of the National Poultry Institute is divided between the Department of Genetics and Animal Nutrition Institute at Cambridge, the South Eastern Agricultural College, Wye, and the Cheshire Farm Institute, Reaseheath. Research into pig problems is similarly divided between the Research Institute in Animal Nutrition at Cambridge, the South Eastern Agricultural College, Wye, and Harper Adams College. Research in foot-and-mouth disease is divided among several veterinary and medical research institutes.

The testing of varieties of fruit trees for their suitability to local soils and climatic conditions is carried on at several research institutes, and county council stations : the headquarters of the scheme being the Royal Horticultural Society's Station at Wisley.

Reference may be made to the cognate subjects of Plant Pathology and Entomology, which together hold a position somewhat different from that of most other agricultural sciences, a difference due partly to the responsibilities imposed on the Ministry by the Destructive Insects and Pests Acts and partly to the fact that the study of plant pests and diseases is not centralised in one or two research stations, but is carried out wherever diseases or pests make their appearance. As a result of these special features, it has been found necessary at practically every college and research centre to provide research and advisory entomologists and mycologists, while in addition at Harpenden the Ministry has set up its own Plant Pathological Laboratory, which provides the scientific basis for the administration of the Acts just referred to and in addition secures a measure of co-operation between the various workers scattered throughout the country. These workers, with the staff of the

'Ministry's laboratory and the Headquarters' and Inspectorial staff engaged in administering the D.I.P. Acts, may be regarded as the Phytopathological Service of the Country, and those interested are referred to a fuller description of the service which appeared in the Ministry's Journal, Vol. 31, 1924/25, p. 331.

With this explanation, however, it will be realised that the subjects of Plant Pathology and Entomology are not organised so largely on an institutional basis as the other agricultural sciences, and in consequence are not fully dealt with in the following pages.

In addition to the research in agricultural economics carried out by the Agricultural Economics Research Institute and by Advisory Economists (see pp. 88 and 97 respectively) a great deal of investigation into marketing problems is conducted by the Markets Branch of the Ministry of Agriculture, the results of which are published by H.M. Stationery Office in a series of reports dealing with the marketing of various commodities, with agricultural credit, with co-operative marketing and with markets and fairs in general. In the investigations on the marketing of agricultural products consideration is given in the first place to the trend of home production and imports: the localisation and seasonality of home production and marketing: the relation of producing areas to consuming centres: the amount and regularity of foreign competition: and long period trend of prices, local variations, and price margins. Investigation in the field is concerned with the factors of production such as economic features of producing areas; quality, breed and variety; crop estimates and forecasts; with the conditions of demand such as market requirements, seasonal fluctuations, local differences and demand in relation to supply; and with the functional aspects of marketing such as assembling, grading and packing, standardisation, transportation, method of sale, markets, storage and distribution.

#### *Status and Subjects of Local Research and Advisory Work.*

Much the same considerations which led to the placing of research institutes at universities have led to the placing of the local research (or advisory) officers at University Departments of Agriculture and Agricultural Colleges. In addition their situation enables these officers to come directly and constantly in touch with the farmers of a limited area, so that they are able to ascertain the most pressing problems of local importance on which research is needed.

A statement of the provinces into which the country has been divided for local research and advisory work, the counties comprised in the province, the provincial advisory centres, and the officers stationed at each is given in the Appendix to this pamphlet.

The local research and advisory officers form part of a scheme for the supply of technical advice to farmers, based on the County Council agricultural staff. Under this scheme requests for advice are made in the first instance to the county agricultural organiser (an officer of the County Council) and in the great majority of cases are dealt with by him. Enquiries which require the advice of a

specialist are, however, passed by the agricultural organiser to the relevant specialist advisory officer at the provincial advisory centre.

For plant pests and diseases there are two sets of specialists at the Provincial Advisory Centre—entomologists and mycologists, who carry out research on troubles caused by (1) insects and (2) fungi and other micro-organisms respectively. It is also the duty of the advisers in entomology and mycology to report each month to the Ministry's Plant Pathological Laboratory, in Harpenden, on the prevalence of pests and diseases of plants in their respective provinces; and these reports form the basis of a Monthly Summary issued by the Ministry. Chemists specialise on soils, manures, feeding and feeding stuffs; economists on questions of farm book-keeping, farm costings, farm management and agricultural economics in general. At some centres there are advisers in veterinary medicine who deal with animal diseases of general public interest in the province, e.g., epidemics or cases of high and long-continued mortality in flocks or herds, and assistants for dairy bacteriology who carry out bacteriological work in connection with clean milk competitions and advise on technical points arising from that work.

#### *Administration of Grants.*

While, as explained above, the two chief funds drawn on for public aid to research work are the Development Fund and the Empire Marketing Fund, the administration of the grants to research institutes and advisory centres is entrusted to the Ministry of Agriculture and Fisheries so far as England and Wales is concerned. Grants are made both for capital (lands, buildings and equipment) and maintenance (salaries, wages, rent, power, materials, loss on experiments, &c.). The maintenance grants cover the whole or practically the whole of the current expenditure both of research institutes and advisory centres. A few research institutes, however (e.g., Rothamsted), have endowments or receive contributions from private sources and it is the policy of the Ministry to encourage the institutes to look to such sources\*. The contribution received through the Ministry of Agriculture and Fisheries is in every case a grant-in-aid, so that, although the institute or centre would in all probability be unable to carry on its work, at any rate on the same scale, if the Ministry's contributions were withdrawn, the final responsibility rests upon the University or other governing authority, and the strict liability of the Ministry ceases when its grant is paid. It is in the highest degree unlikely that Parliament would cease to vote money for the prosecution of research in agriculture or that support would cease to be given to Research Institutes and Advisory Centres, but the adoption of the system of annual grants-in-aid ensures (1) that the institute or centre retains its power of self-government, and (2) that the work and administration of the institute or centre

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\* The John Innes Horticultural Institution (p. 57) is independent of Government aid.

must justify the support for which it asks. This method of control by grant-in-aid without direct administrative responsibility is, of course, a usual feature of the British system of administration. By applying the method to agricultural research it is hoped to combine the minimum of State interference with the most favourable conditions for carrying out research.

Co-ordination of research work is secured mainly through the Agricultural Research Council, which consists of the Directors of Research Institutes and certain other scientific men and discusses common problems of work and staffs, and arranges joint investigations. The directors of the Scottish research institutes are members of the Research Council, so that co-ordination of work is secured throughout Great Britain.

In the same way there are regular meetings of local research officers in the different specialist subjects, which are also attended by research workers: by this means such officers are kept informed of the methods, work and results of their colleagues and joint schemes of work are planned.

## (2).—Scotland.

### *Agricultural Research.*

Agricultural research in Scotland is organised on the same lines as in England under the Board of Agriculture for Scotland, and the general account given of the English scheme applies equally to the Scottish. There are several permanent institutions, each working on problems relating to one branch of agriculture ; there is a service of advisory officers attached to the Agricultural Colleges with the duty of investigating problems of a local nature and also of providing specialist technical advice to farmers, and special investigations into particular subjects are carried out by members of staff either of research institutions or of the Agricultural Colleges or the Universities.

### *Permanent Research Institutions.*

Particulars of the situation, staffs, aims and work of the Scottish research institutes will be found in the subsequent section, pp. 12-96.

### *Advisory Officer Service.*

This service is similar to that in England and Wales. For purposes of agricultural education Scotland is divided into three provinces—North-east, West, and South-east—with Colleges situated at Aberdeen, Glasgow, and Edinburgh, each having associated with it eleven or twelve counties. In each county or group of counties an organiser,\* assisted by extension lecturers, carries on educational, advisory, and demonstration work, but in addition there is a specialist Advisory Service attached to the College Provinces as shown in the Appendix to this pamphlet.

There is besides on the Board's staff a Plant Pathologist specially engaged on research and advisory work in connection with diseases of horticultural plants for the whole country.

### *Co-ordination.*

As previously explained, the Agricultural Research Council of Great Britain includes directors of Scottish research institutes, and Scottish administrators. In addition a committee of the senior research workers meets at stated intervals, and special sub-committees are formed to carry out team-work on particular problems.

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\* The organiser in Scotland is an officer of the Agricultural College and not, as in England, of the County Council.

### (3).—Northern Ireland.

Research and advisory work in Northern Ireland is directly under the control and administration of the Ministry of Agriculture, Northern Ireland. Six research divisions have been established, namely :—

- (1) The Chemical and Animal Nutrition Division.
- (2) The Seed Testing and Plant Diseases Division.
- (3) The Plant Breeding Division.
- (4) The Poultry Division.
- (5) The Animal Diseases Division.
- (6) The Crop and Animal Husbandry Division.

The Chemical and Animal Nutrition Division, the Seed Testing and Plant Diseases Division and the Crop and Animal Husbandry Division are stationed at the Queen's University of Belfast and the remainder in the Government grounds at Stormont, five miles from the centre of the city of Belfast. All the members of the research staff are permanent Civil Servants.

The main function of each of these Divisions is research and experimental work, but each of them performs a certain amount of routine work in connexion with the administrative functions of the Ministry and also teaching work in connexion with the University Faculty of Agriculture. It may be noted that the official Seed Testing Station for Northern Ireland is incorporated with the Seed Testing and Plant Diseases Division.

In Northern Ireland no attempt has hitherto been made to develop research work along purely academic lines. The aim has been to concentrate research and experimental work upon problems of immediate economic importance to the agricultural industry of Northern Ireland and to look to the special Research Institutes in England and Scotland for developments along what may be termed fundamental lines.

Facilities for research and experimental work have been augmented by the provision at a cost of approximately £48,000 of new Agricultural buildings at the University, and a central Research and Experimental Farm situated at Hillsborough, Co. Down, approximately 12 miles from Belfast. The Research and Experimental Farm together with the endowment fund are vested in nine trustees, three of whom are appointed by the Ministry of Agriculture, three by the Ulster Farmers' Union, one by the Ulster Agricultural Organization Society and two by the Faculty of Agriculture of the Queen's University. The two trustees appointed by the University act as joint directors of the station, the head of the Crop and Animal Husbandry Department being responsible for the management of the farm and the head of the Chemical and Animal Nutrition Department for the research and experimental work.

*Advisory Work.*

Neither the Ministry nor the County Councils maintains a separate advisory staff. The Agricultural Committee of each County Council employs at least one Instructor in each of the following subjects :—agriculture, horticulture, poultry-keeping and buttermaking. Advisory work in the first instance is undertaken by these officers and by the Ministry's technical Inspectors. Any such work which cannot be so dealt with is referred to the appropriate research division which in subsequent developments keeps in touch with the county staff. Every effort is made to keep the advisory work of the research divisions within reasonable limits. Experience has shown that the association of the research divisions with the advisory work is of great value inasmuch as advisory problems are frequently the means of directing the attention of the research staff to problems of real economic importance. It also affords a valuable means of bringing the research staff into direct contact with the farming community, and of making their work known and appreciated.

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An account of research institutes : their situation, staffs, aims and general surveys of work will be found on pp. 12–96. Abstracts of papers dealing with their work, issued in the six months October, 1926, to March, 1927, are given in a separate publication of the Imperial Agricultural Research Conference.

**II.—RESEARCH INSTITUTES,  
DEPARTMENTS AND DIVISIONS:  
THEIR SITUATION, STAFFS, AIMS  
AND WORK.**

**A.—Soils and Crops.****THE ROYAL SOILS AND CROPS  
EXPERIMENTAL STATION,  
HARPENDEN, HERTS.**

Railway Station:—Harpenden 1. M.S. Telephone) Harpenden 21.  
 Telegrams] Staff.

*Director*:—Sir E. John Russell, O.B.E., D.Sc., F.R.S.  
*Assistant Director*:—B. A. Keen, D.Sc., F.Inst.P.

**Heads of Departments**

Bacteriology	..	H. G. Thornton, B.A.
Botany	..	Wimber E. Brenchley, D.Sc., F.L.S.
Fermentation	..	E. H. Richards, B.Sc., F.I.C.
Insecticides and Fungicides	..	F. Tattersfield, B.Sc., F.I.C.
General Microbiology	..	D. W. Cutler, M.A., F.L.S.
Soil Physics	..	B. A. Keen, D.Sc., F.Inst.P.
Statistical	..	R. A. Fisher, M.A., Sc.D.
Entomology	..	A. D. Imms, M.A., D.Sc., F.L.S.
Mycology	..	W. B. Brierley, D.Sc., F.L.S.

**Other Members of Graded Staff**

Assistant Physicist	..	G. W. Scott Blair, B.A.
Assistant Microbiologist	..	Miss L. M. Crump, M.Sc.
" Entomologist	..	J. Davidson, D.Sc., F.L.S.
Ecologist	..	T. Eden, M.Sc.
Chemist	..	C. T. Gimingham, B.Sc., F.I.C.
Assistant Mycologist	..	Miss M. D. Glynn, M.Sc.
" Bacteriologist	..	P. H. H. Gray, M.A.
" Entomologist	..	D. M. T. Morland, M.A.
Chemist	..	W. A. Roach, B.Sc., A.I.C.
Assistant Microbiologist	..	H. Sandon, M.A.
" Mycologist	..	J. Henderson Smith, M.B., Ch.B.
" "	..	R. H. Stoughton, B.Sc., A.R.C.S.

**Aims of the Station.**

The purpose of the Rothamsted Experimental Station is to obtain information on soil conditions and the growth of plants, and to use this knowledge in advancing agricultural science, in improving the standards of farming and in agricultural education. The general method of investigation is to start from the farm and work to the laboratory or vice versa.

There are four great divisions in the laboratory—biological, chemical, physical and statistical—which may be regarded as the pillars on which the whole structure rests. But the method of investigation differs from that of an ordinary scientific laboratory, where the problem is usually narrowed down so closely that only one

factor is concerned. On the farm such narrowing is impossible; many factors may operate and elimination results in conditions so artificial as to render the enquiry meaningless. In place, therefore, of the ordinary single factor method of the scientific laboratory, liberal use is made of statistical methods which allow the investigation of cases where several factors vary simultaneously. In the crop investigations a large number of field observations are made; these are then treated statistically to ascertain the varying degrees to which they are related to other factors—such as rainfall, temperature, &c.—and to indicate the probable nature of the relationships. Thus the complex problem becomes reduced to a number of simpler ones susceptible of laboratory investigation.

In addition to the classical field experiments laid down by Lawes and Gilbert from 1839 onwards, many other field trials are made on the Rothamsted farm. Some of the more important are repeated elsewhere, in order to assess the influence of different soil and climatic conditions. Some fifty centres throughout the country are used for this purpose, in addition to the Woburn Experimental Farm, where field plots were laid down in 1877 to repeat on light land the permanent experiments instituted earlier at Rothamsted.

The facilities provided by the Station for post-graduate workers, especially those from overseas, and agricultural officers on study leave, have been extensively utilised.

### Summary of Work.

For convenience the work in progress is summarised under the following main heads:—(I) Soil problems, (II) Fertiliser investigations, (III) Factors affecting plant yield and quality of produce, (IV) Control of disease, (V) Field experiment procedure. These divisions are not rigidly maintained in the work; many borderline problems are under co-operative investigation by several laboratories in the institution.

#### I. Soil Problems.

These may be again divided into (*a*) chemical, (*b*) physical, and (*c*) biological.

(*a*) *Chemical.*—Extensive laboratory work is in hand on the humic material of the soil. Its mode of formation and its relation to the nitrogen supply of the soil have a close bearing on practical questions of organic manuring, and on certain aspects of soil fertility.

The relation of the exchangeable bases in the soil to its fertility is also being studied. The classical plots at Rothamsted and Woburn provide unique material for this investigation, as many of the effects of manures (e.g. soil acidity) have been accentuated by the long continuance of the treatment.

The serious increase in the area of acid soil in this country has necessitated especial attention to methods of measurement, and to

remedial measures ; a beginning has also been made in the analogous problem of alkalinity that faces many irrigated areas in the Empire.

(b) *Physical*.—The yield of crops is determined not only by the content of available nutrients but also by the physical condition, or tilth, of the soil. Physical studies of the aggregation of particles into the compound aggregates characteristic of tilth show that both mechanical and colloidal factors are concerned. Special apparatus has been devised for measuring cohesion, plasticity and many of the complex water relationships ; and the work has been extended to direct field studies and comparisons of cultivation processes. As cultivation is still the most costly single item in the farmer's expenditure, attention is being given to methods of improving its efficiency and reducing its cost. Heavy dressings of chalk on strong land not only improve its texture but are found to ensure a lasting reduction in the resistance of the soil to the passage of cultivation implements.

In the field experiments much use is made of a recording dynamometer. Fields apparently uniform to visual inspection show surprisingly wide variations in resistance from point to point, but fortunately, these variations do not alter appreciably from year to year. Hence, by a previous survey it is possible to allow for them when comparing the relative efficiencies of different implements.

(c) *Biological*.—The study of the activities of the soil population constitutes one of the most important sections of the Rothamsted programme. The population is highly complex : bacteria, protozoa, fungi, algae, and insects are studied in their relations to one another, to soil fertility and plant growth. Bacteria and protozoa rapidly fluctuate in numbers, certain species of the latter exhibiting a remarkable inverse relationship with the total bacterial numbers. The life cycle and physiology of certain of the more important species of bacteria and protozoa are being worked out with special reference to methods of control of the soil population. For some time past steam and volatile antiseptics have been used for this purpose in glass house practices. The extension of their use was the direct outcome of investigations at Rothamsted ; the technical problems in their application were sufficiently important to necessitate the establishment, in the centre of the industry, of a separate research station, which maintains close co-operation with Rothamsted, where the fundamental problems are still being studied.

Much of the work on the soil population is directly related to plant growth and fertiliser investigations, and is referred to under those headings.

## II. Fertiliser Investigations.

These may be broadly grouped into (a) artificial manures (b) organic manures.

### (a) Artificial Manures.

*Phosphatic manures*.—The agricultural properties of the three kinds of basic slag now available (Bessemer, Open Hearth high soluble

and Open Hearth low soluble are being studied and chemical methods are being devised to evaluate them.

The solubility in the official 2 per cent. citric acid solution is proving to be a useful and easily applied test of value. Other constituents of the slag, however, appear to play a part so that the indications afforded by any one test are not always in accordance with the results of field experiments. Broadly speaking the variations among slags of solubility below 60 per cent. are generally in accordance with the solubility, while those among slags of 70 per cent. or more solubility usually are not. A new method of examination is being worked out with special reference to the fine-grained.

The uptake of phosphate from the soil and added phosphatic fertilisers by the growing plant is receiving extended study in both field and pot experiments; mineral phosphates, slags, and super-phosphate are being contrasted and compared in this work.

*Potassic fertilisers.*—The quality of crop produce is improved by potassic fertilisers and attempts are being made to express this in chemical terms. The action between these manures and the soil is under investigation as part of the work on base exchange already mentioned.

*Nitrogenous fertilisers.*—The number of compounds e.g. calcium cyanamide, on the market capable of supplying nitrogen in an available form steadily increases. Their mode of action and factors influencing this are under investigation.

*Other elements influencing plant growth.*—There is evidence that certain compounds, such as silicates, can either augment the effect of artificial manures, or, in part, replace them. Other substances such as boron and manganese, are essential to the proper development of the plant; these phenomena are being critically studied and the possibility of applications to practice is being watched.

#### (b) *Organic Manures.*

The quantity of farmyard and stable manure is less than could usefully be absorbed by the farming industry. Two methods of supplying organic material to the soil are being investigated.

*Green manuring.*—This well established practice is being studied with a view to its extension. Field trials have been laid out with the co-operation of the Royal Agricultural Society of England in different parts of the country, and different systems are being compared. The laboratory work forms one section of the humus material investigations already mentioned.

*Synthetic Farmyard Manure.*—A laboratory investigation of certain organisms capable of attacking cellulosic material led to the development of a practical method of rotting down waste vegetable matter. This process has been utilised successfully, not only in this country but in many parts of the Empire, and its commercial

development has been transferred to a non-profit making syndicate (Agricultural Developments Company). In the Rothamsted laboratories, investigations are in progress on the more resistant materials, and especial attention is being paid to the part played by fungi as distinct from bacteria.

### *III. Factors Affecting Crop Yields and Quality of Produce.*

Although yield is, and must be, the main consideration for most farm crops, questions of quality are becoming increasingly important; in many cases, e.g. potatoes and malting barley, expert valuers have evolved their own methods for assessing quality and fix the price they are prepared to pay on that basis. Samples of produce, graded and valued in this way by a committee of valuers, are being examined in the laboratory in order to see what relations exist between chemical and other properties and the valuation. At the same time the whole growth period of the crops is being followed by frequent physiological measurements, to ascertain the most significant periods and environmental conditions that determine the final yield and quality. These general principles of attack apply to the separate investigations detailed below :—

*Malting Barley.*—Samples of barley grown under known manurial conditions in the chief barley growing districts of the country, and of malts made therefrom, are being examined. A critical study is also being made of the relation of the nitrogen compounds of barley to its malting value. Further information on the development of the crop is being sought by pot and water culture experiments in which phosphorus, potassium and nitrogenous compounds are supplied for limited periods only instead of throughout growth.

*Sugar Beet ; Mangolds.*—The influence of manuring, potassic, phosphatic and nitrogenous, and of spacing and time of sowing, on yield and sugar content of sugar beet is being studied both at Rothamsted and Woburn. Chemical examination is being made of the mangolds from the permanent plots on Barnfield, where the long continued manurial treatments have accentuated differences due to nutritional factors.

*Potatoes.*—Considerable attention is devoted to the potato crop owing to its importance in British agriculture. The investigations include the effect of fertilisers on yield and quality, the relations between quantity of fertiliser and amount of growth and the effect of various ratios of plant nutrients. Studies are also made of the effect of chlorine on yield and quality.

The chemical investigations include determinations of starch and other constituents, but none of these is simply related to cooking quality or to nutrient supply ; there is a considerable seasonal effect which is not yet understood.

*The Influence of Season on the Yield and Quality of Produce.*—Agriculturists are familiar with the profound effect of season in

modifying the effects of fertilisers and soil treatments. This effect is under investigation.

The method adopted is to obtain field data of known accuracy and then to correlate these with the meteorological observations. This has necessitated complete revision of the methods of conducting field experiments, the older methods being unsuitable for statistical investigation.

*The Leguminous Crops.*—These stand in rather a different category from the remaining crops of the farm by reason of their association with certain of the soil micro-organisms.

*Lucerne.*—A study of the life history of the nodule organism associated with this legume has shown that the period during which it is motile, or capable of independent movement in soil, can be increased by additions of phosphate. This knowledge has been applied in an improved method of inoculating lucerne seed. In co-operation with the Royal Agricultural Society of England field trials are being made at some fifty centres in Great Britain, to ascertain whether inoculation and suitable cultivation methods will enable the crop to be successfully grown outside the present limited area—the East and South-East of England. Marked success has attended this experiment; inoculation has not only produced good crops where none could be grown before, but in cases where the crop was grown, it has frequently resulted in increased yields, increased percentage of nitrogen in the tops, or both.

*Physiology of Leguminous Crops.*—In water culture experiments the growth of many leguminous plants is often unsatisfactory, although adequate supplies of the conventional nutrients are present. The presence of boron in minute quantity has been shown to be essential for satisfactory growth. The physiological action of this element is connected with nodule formation. In its absence abnormal and useless nodules are produced and the helpful symbiotic association between the plant and the nodule organism (*Bacillus radicicola*), is replaced by a parasitic relationship.

#### IV. Control of Disease.

It is difficult to obtain any reliable estimate of the annual loss to British farmers directly due to plant diseases, but the best judges consider that it is at least 10 per cent. of the total value of the crop. The causes of many diseases are still obscure, and much fundamental work remains to be done before preventive or remedial measures can be evolved. This is especially true of the group known as virus diseases. Meanwhile many of the problems are urgent and empirical methods of control must be tried, or alternatively a search for immune varieties of plants must be made. The causes of virus diseases are unknown, but the remainder may be conveniently divided into (a) microbiological, and (b) insect attacks.

*a. Fungal Diseases.*—These are by far the most important of the first group. The problems are much complicated by the wide variations in virulence found in different strains of a given fungus, that are indistinguishable in their morphological characteristics. It is necessary to use physiological criteria in the study of the relations between the plant and its parasites. Unfortunately, little information of this kind exists at present; as a preliminary much general work is being carried out.

The wart disease of potatoes has received considerable attention, not only because of the importance of the potato crop in Britain, but also because the sharp division into immune or susceptible varieties introduces a simplification in the complex problem of immunity. Several converging lines of work on the general problem are in hand: a rapid and reliable method of testing immunity or susceptibility has been developed; tests have been made of the effects of various factors on the viability of the sporangia of the fungus that rest in the soil over the winter; a direct attack has been made on the physiological nature of immunity by grafting tops of immune varieties on to roots of susceptible varieties and vice-versa and then examining the properties of the tubers formed above and below the graft; closely associated with this aspect of immunity is the study of incipient infection that in suitable conditions can be induced on shoots of immune varieties, an infection that does not develop beyond the stage of liberation of summer sperangia.

The physiology and genetics of the smut fungi are being studied with especial reference to diseases of cereal crops.

*b. Insect Attacks.*—In general the effect of insect infestation is a direct destruction of portions of the plant to a stage that prevents it from developing normally, rather than any true physiological change. The general method of laboratory investigation is to work out the life history of the insect in question, with special attention to its most susceptible periods and the alternative host plants, in order that measures of control may be carried out at the most suitable periods. Especial attention has been given to the reproduction and migration of Aphides, more particularly those infesting Beans, and the Hop-Damson *Aphis*.

*Control of Disease.*—In addition to avoidance of disease by the development of immune varieties of plants, direct measures of control are employed, both against fungus diseases and insect attacks:

*Wart Disease of Potatoes.*—The effect of finely divided sulphur thoroughly incorporated with the soil has been followed up in field experiments. The results are very variable and depend on climatic conditions and soil factors. The investigation has therefore been extended to include a study of the changes sulphur undergoes in the soil in varied conditions of temperature, moisture, and manurial treatment. A number of complex sulphur compounds are also being directly tested for their toxicity to Wart Disease.

*Insecticides.*—The insecticidal action of plant extracts and synthetic organic compounds is being studied both upon adult insects and their eggs, in an attempt to correlate chemical constitution and physical properties with toxic action on plant pests and disease organisms, and to find suitable compounds for use both as summer and winter washes. A large number of chemical substances are therefore being tested in the laboratory by means of a spraying machine devised to give quantitative comparisons of their contact insecticidal action. The most potent of the compounds are selected for trial in the field.,

Quantitative investigations are being made of the insecticidal effect of stomach poisons and the tolerance of the foliage to them.

Experiments on a glasshouse scale are being carried out with various chemicals with the object of discovering new materials for partial sterilisation of soil and for eliminating soil pests.

*Biological Control.*—Another possible method of controlling insect pests is by means of their parasites. This is of especial promise in newly developed areas where the insects may have been introduced recently, and, in the absence of their natural parasites, have multiplied unchecked. The procedure is to make investigations of any parasitised specimens found in the country of origin, and to devise suitable means for their transportation to, and liberation in the areas affected. Recent Rothamsted investigations have dealt with the control of earwigs in New Zealand ; at the request of the United States Department of Agriculture, consignments were also sent to Oregon. The problem of controlling the frit-fly of oats by similar means has also been taken up.

*Control of Noxious Weeds.*—This is in a sense the complementary problem to insect control, the aim being to introduce suitable insects to attack weeds in regions where the latter have abnormally increased. In conjunction with the Cawthon Institute, New Zealand, an attempt is being made to check, by biological control, the spread of the bramble and gorse in that country.

#### *Field Experiments.*

The advances in our knowledge of soil conditions and plant growth have necessitated corresponding improvements in the design of field plot experiments. It has become essential to have results that are not only more accurate than before, but to obtain them in a shorter time. The first step was to make a mathematical examination of the problem, taking into account the non-uniform or heterogeneous nature of the soil. It is now possible to lay down definite rules for the design of the experiment and the statistical treatment of the yield data under which results of known accuracy may be obtained.

The work has been further extended to a study of the effect of climatic factors. For this purpose the long series of records from the classical Rothamsted field experiments have been used.

The value of the newer system of field plot design is not confined only to increased accuracy of the yield figures. Quantitative observations are made on the plants throughout the season, of rates of growth, net assimilation, uptake of nutrients and maturation of the grain. This information throws light on the physiology of the response of the plant to manurial, seasonal and soil factors.

#### *Other Activities.*

*Agricultural Investigations.*—Studies are being made of changes in temperature, moisture and carbon dioxide inside the hive, and of their relations to environmental conditions. Other problems under investigation are related to the type of combs and their position inside the hive.

*Lectures and Demonstrations to Farmers.*—There has been a large and increasing demand from farmers' organisations, agricultural colleges and similar bodies, for lectures and demonstrations by members of the staff on various aspects of agricultural science. The demand has increased to an extent that has necessitated the services of a whole-time guide-demonstrator to relieve the senior members of the staff of some of this work.

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(2) SOILS AND DRAINAGE DEPARTMENT.  
 NORTH OF SCOTLAND COLLEGE OF AGRICULTURE AND  
 UNIVERSITY OF ABERDEEN.

*Laboratories* situated at Marischal College, Aberdeen. *Nearest Railway Station*: Aberdeen. *Telephone*: Aberdeen 1096.

*Lysimeters* situated at Craibstone Experimental Farm, Bucksburn, Aberdeen. *Nearest Railway Station*: Bucksburn or Bankhead.

### Staff.

*Head of Department*, Professor James Hendrick, B.Sc., F.I.C.

*Soils Advisory Officer*, George Newlands, M.A., B.Sc., F.I.C.

### Aims of the Department.

The Research Department is specially concerned with investigation into the properties and fertilisation of soils, and the losses which manured and cropped soils suffer through drainage. The conditions and composition of Scottish soils and the requirements arising from the systems of agriculture followed in Scotland are particularly kept in view.

### Summary of Work.

*Soil Investigation*.—The soils of Great Britain are mainly derived from the glacial materials left as a covering when the ice sheets and glaciers of the great ice age finally disappeared from the country. Investigations made at this centre have shown that the soils of the north and north-east of Scotland differ from most of the English and South of Scotland types in containing greater amounts of unweathered minerals and therefore greater reserves of lime, magnesia, potash and soda, the principal chemical bases necessary for plant life. Further study of Scottish soils showed that they were capable of subdivision according to the kinds of minerals which were predominantly present, and that the soil groups so formed were largely determined by the nature and composition of the parent material from which the soils arose.

In addition to the influence of the parent material in determining soil types other factors such as climatic and other external conditions under which the soil has developed have to be taken into account. At present Scottish workers are engaged in an attempt to arrive at a scheme of classification which will assess the various factors at their proper value and prove satisfactory agriculturally. A soil survey will then be made recording the distribution of the several types by means of maps. With this object in view a programme of work for the study of soil features, as found in the field, has been entered upon. A study of their characteristics shows that the soils of Scotland belong to the group occurring in temperate and humid regions and that

within this group are subtypes whose properties are determined by the kind of material from which they have developed and the local conditions of topography and vegetation under which they have developed.

Field study is supplemented in the laboratory by investigation of the mechanical and chemical composition of the soil. Recently a part has been taken in a revision of the British methods of mechanical and chemical analyses of soils, and in an international investigation as to the comparative merits of the methods adopted by various countries. Recent work on the question of the nature of the colloidal part of the soil has thrown fresh light on the problems of soil acidity and availability. Studies have been made of the colloidal matter and exchangeable bases of local soils by the new methods which have been devised and elaborated during recent years by well-known soil workers.

*Lysimeter Investigations.*—In order to obtain complete and exact information concerning what is leached from the soil by the water which passes through it, we require to know the amount of drainage which comes through the soil and its composition. When the experimental farm of Craibstone was acquired by the North of Scotland College of Agriculture it was decided to undertake drainage investigations and to construct a set of lysimeters. A set of three was constructed in 1914, each one-thousandth of an acre in area and forty inches deep, enclosed in slate slabs in such a way that the soil and subsoil are in the natural, undisturbed state. Suitable vessels are installed below in which the drainage is collected and measured. By means of these lysimeters the amount of the rainfall which percolates through the soil is measured. The main purpose of these lysimeters is to measure the amounts of lime, potash, nitrates and other constituents of value which are washed from the soil under the different conditions which are represented by the different plots, one of which is unmanured, another is manured both with dung and artificials, while the third is similarly manured and also limed. The lysimeters are all cropped in the same way as the surrounding field. Analyses of the drainage waters are made monthly and analyses of the crops grown and the manures applied are also made.

In addition to the regular analyses performed in connection with the lysimeter work determinations are made of substances brought down by the rain water which is collected alongside the lysimeters.

Numerous drainage investigations have also been made with small tanks artificially filled with soil and subsoil.

(3) CHEMICAL [AND ANIMAL NUTRITION] DIVISION:  
MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

This Division is stationed at the Queen's University, Belfast.

**Staff.**

<i>Head</i>	...	...	G. S. Robertson, D.Sc., F.I.C.
<i>Chief Assistant</i>	...	...	F. Dickinson, B.Sc., F.I.C.
<i>Assistant (Animal Nutrition)</i>			R. G. Baskett, B.Sc.
<i>Assistant (Dairy)</i>	...	...	J. Houston, M.Sc.
<i>Assistant (Soils)</i>	...	...	Vacant.

**Summary of Work.**

The research and experimental work of the Division falls into two main sections :—

1. Animal Nutrition.
2. Soil and Fertilizer Problems.

1. *Animal Nutrition*, see p. 77.

2. *Soil and Fertilizer Problems* :—

An investigation carried out during the years 1921–26 inclusive as to the relative value of ground mineral phosphates compared with high grade basic slag, superphosphate and other phosphatic fertilizers has been completed and a report has been published. The results show that (1) ground mineral phosphates of the North African type are as effective per unit of phosphate as high grade basic slag : (2) ground rock phosphates are practically as effective per unit of phosphate as superphosphate for the turnip crop, but give greatly inferior results as a source of phosphate for the potato crop : (3) finer grinding beyond the "100 mesh" sieve does not materially increase the effectiveness of rock phosphate, and (4) it is not necessary to apply rock phosphates several months before the crop is sown.

A series of experiments has been carried out on various crops to compare the relative values of several nitrogenous fertilizers, and in particular chloride of ammonia and urea as sources of nitrogen.

*Soils*.—Field experimental work, commenced in 1924, is being continued with the object of ascertaining whether the "lime requirement method" affords a practical indication of the lime requirements of Northern Ireland soils.

(4). RESEARCH INSTITUTE IN PLANT PHYSIOLOGY:  
IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY,  
LONDON.

The Research Institute, which is associated with the Botany Department of the Imperial College, stands on the north side of the west end of Prince Consort Road, South Kensington. The nearest, and equidistant, stations are those of Gloucester Road and South Kensington on the District Railway. Telephone: Kensington 7118.

**Staff.**

*Director.*—Professor V. H. Blackman, Sc.D., F.R.S.

*Graded Staff.*—R. C. Knight, D.Sc., F. G. Gregory, D.Sc., B. D. Bolas, M.Sc., O. W. James, Ph.D.

**Aims of the Institute.**

The work of the Research Institute in Plant Physiology is mainly directed to the elucidation of the physiological processes of the plant on which crop yield, both in the field and under glass, depends. The Institute works in close association with the Research Institutes at Rothamsted and East Malling. A few of the more recent investigations carried out by the Institute are indicated below.

**Summary of Work.**

*Effect of Meteorological Conditions on Plant Growth.*—The dominant factor in plant yield is that set of climatic conditions known as "weather," and the effect of these has been studied by growing plants in the open and recording their growth throughout the season, while at the same time careful records are made of the light, temperature, humidity and other conditions. A statistical comparison of the variations in the physiological processes of the plant, on the one hand, with the concomitant changes in the weather, on the other hand, gives a picture of the effect of the different external conditions on the growth and development of the plant. With barley growing in the open the physiological processes studied were the assimilation rate (*i.e.*, the net uptake of food material by the leaves), the relative rate of increase of plant material (*i.e.*, the rate at compound interest at which the dry weight of the plant increases), and the relative rate of growth of the leaf surface. The results indicate very clearly the physiological adaptation of the plant to climatic changes. It is found that the rate of food production, and accordingly the rate of growth, is kept singularly constant whether the conditions are of high light intensity, as in a bright summer, or low light intensity, as in a dull summer. This relative constancy is due to the fact that while bright light reduces the rate of leaf-growth, the total leaf surface, though smaller, acts more efficiently in the bright light available. In a dull light, on the other hand, the leaf surface is larger but area for area less effective. The plants thus maintain a fair level of activity in spite of widely fluctuating weather conditions. It

is found also that low night temperatures are favourable to the accumulation of food material by the plant, as they reduce the wasteful consumption of material in respiration, for the rate of this process rises and falls with the rise and fall of temperature.

*Physiological Effect of Mineral Fertilisers.*—Parallel with the above study an investigation of the physiological effect of mineral fertilisers is being made, not by a mere study of final yield, but by following *throughout the whole season* the change in the growth of the plant. The physiological basis for the increase of yield can thus be elucidated.

*Electroculture.*—The Institute has also been engaged for some time in a study of the effect of electric discharges on crop-yield. The work has for the last few years been carried out by means of pot-cultures, since the experimental error can in this way be reduced to small dimensions and significant results obtained much more quickly. The data obtained show clearly that minute electric currents supplied from overhead networks cause a definite increase in the yield of barley. An analysis of this increased yield indicates that it is generally independent of any increase of vegetative growth, but the ears of the electrified plants show a larger proportion of fertile flowers than do those of the control plants. There are indications also that the effect is closely associated with the quality and quantity of fertiliser given. The experimental work has not yet reached an economic stage, but the electrical effect is undoubtedly.

*Change of Seed in Potatoes.*—The question of the necessity for "change of seed" in potatoes has also been under investigation. Potatoes have been grown for several years in succession, and a comparison made between yields from fresh Scotch seed and from "home grown" seed one year old, two years old, etc. No evidence was obtained, at least within a period of a few years, of the commonly accepted "physiological degeneration." If the crop is kept free from virus diseases the yield from "thrice-grown" seed may be as high or higher than that from fresh Scotch seed.

*Carbon Dioxide Investigation.*—The effect of changing the concentration of carbon dioxide of the air is now under investigation. It has often been claimed—and the effect is an undoubtedly—that increase of the supply of this gas (which is the main food supply of the plant) will increase the growth of crops. The effect is of importance in the glasshouse industry, but hitherto there has been no serious physiological study of the problem and the question of the most suitable concentration to be supplied is still unknown. A preliminary study has already shown that, with cucumbers, increases in dry weight of 80 per cent. can be obtained in a few weeks by increasing the concentration of carbon dioxide from the normal 3 parts in 10,000 to 15 parts.

Other problems under investigation have been a study of the rooting of cuttings, of apple stocks, and of the effect of stem pruning on the subsequent growth of root and shoot.

### (5) PLANT BREEDING INSTITUTE : CAMBRIDGE UNIVERSITY.

The experimental grounds of the Plant Breeding Institute are on the University Farm, Huntingdon Road, Cambridge. These are equipped with bird-proof cages for the protection of the more important hybrid cereals at various stages of growth and during their earlier yield trials: with greenhouses, storage rooms and a small machine room for threshing and seed cleaning. The larger plots are handled almost entirely on the Farm, whilst the produce of the smaller plots, for instance of cereals at the  $F_2$  and  $F_3$  stages, is transferred to the School of Agriculture, Cambridge, for more detailed examination. There a general sorting room, a chemical laboratory, and a mill room have been fitted up as well as rooms for the research staff. *Telephone*: Cambridge 1885.

#### Staff.

<i>Director</i>	...	...	Prof. Sir R. H. Biffen, M.A., F.R.S.
<i>Assistant Director</i>	...		F. L. Engledow, M.A.
<i>Assistant</i>	...	...	H. Hunter, D.Sc.
<i>Assistant</i>	...	...	A. E. Watkins, M.A.

#### *Special Staff for Virus Diseases of Potatoes.*

<i>Assistant Director</i>	...	R. N. Salaman, M.D.
<i>Entomologist</i>	...	K. Smith, D.Sc.

#### Aims of the Institute.

The main work of the Institute centres round the problem of breeding improved types of the plants cultivated as farm crops in this country. The general plan with each of the crops under investigation is to collect together all available varieties and make a preliminary study of the mode of inheritance of all of their more important characteristics with the object of systematizing the investigations and leaving as little as possible to chance. Any promising new forms obtained are given critical small-scale tests and if found satisfactory are handed over to the National Institute of Agricultural Botany for large scale tests, multiplication and distribution.

#### Summary of Work.

Up to the present most progress has been made with the cereal crops and a considerable number of new forms of wheat, barley and oats are now awaiting field trials and multiplication.

*Wheat*.—The chief problems associated with the improvement of wheat are concerned with the production of (*a*) forms better suited for bread-making than those generally grown in this country, (*b*) rust and mildew resistant forms, (*c*) forms more suitable for intensive cultivation and (*d*) rapidly maturing types for spring sowing. In

addition a cytological investigation on crosses between races of wheats differing in their chromosome numbers is in progress.

*Barley*.—The two main lines of investigation with the barley crop have as their object the production of better forms for feeding and for malting purposes. The work has again involved an examination of the possibility of breeding for resistance against such diseases as mildew and *Helminthosporium* and a detailed examination of several problems associated with malting quality. A series of six-rowed barleys suitable for autumn sowing has recently been raised and is now under trial under ordinary farming conditions.

*Oats*.—The chief problem with the oat crops is the production of satisfactory winter hardy forms. After a long-continued comparison of existing forms work has been concentrated on hybrid derivatives of the grey winter oat and a number of these have been tested out during the past two seasons. Progress is also being made with the breeding of spring oats.

*Other Crops*.—Preliminary work on the possibilities of improving beans, peas, lucerne, sugar beet, kohl rabi, marrow stem kale, cabbages and other brassicae, is also being carried out.

The task of raising stocks of seed potatoes free from various virus diseases has recently been undertaken by the Institute.

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(6) WELSH PLANT BREEDING STATION, UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

The Station is situated at Aberystwyth, Cardiganshire (G.W.R.), about 6 hours from Paddington and  $2\frac{1}{2}$  from Shrewsbury. The laboratories are at the Agricultural Buildings nearly opposite the railway station. The gardens (5 acres) are on the outskirts of the town ( $\frac{1}{2}$  mile distant) and the farm (Frongoch, 96 acres) is distant about  $1\frac{3}{4}$  miles from the laboratories. Postal address, Agricultural Buildings, Alexandra Road, Aberystwyth. Telephone: Aberystwyth 105.

**Staff.**

<i>Director</i>	..	Professor R. G. Stapledon, M.B.E., M.A.
<i>Plant breeding and Genetics.</i>		T. J. Jenkin, M.Sc., in charge of grasses. R. D. Williams, M.Sc. „ „ „ clovers. E. T. Jones, B.Sc. „ „ „ oats.
<i>Agronomy</i>	..	William Davies, M.Sc. „ „ „ grass- land.
		Martin G. Jones, M.Sc. „ „ „ oats.
<i>Plant Pathology</i>	..	Miss K. Sampson, M.Sc. D. Walters Davies, B.Sc.
<i>Plant Physiology</i>	..	M. A. H. Tincker, M.A., M.Sc.

**Aims of the Station.**

The aim of the Station is to conduct researches in relation to plant breeding in a manner most likely to benefit farmers occupying areas in high rainfall districts and at high elevations, and generally under conditions of low and relatively low fertility.

Chief attention is therefore given to herbage plants: and researches are also being conducted on the whole question of the management of grassland, particularly temporary grass. Of ordinary arable crops, oats is the only one which is receiving serious and critical attention at the Station from the point of view of plant breeding and of agronomy.

**Summary of Work.**

The work that has been undertaken and that is in progress and which is likely to be of the greatest interest from the Imperial point of view may be briefly summarised as follows:—

*Herbage Plants: breeding.*—The chief species under review are Italian and perennial rye-grasses, cocksfoot, timothy, the fescues, tall oat grass and *Phalaris spp.*, red clover, white clover, subterranean clover and lucerne. It will be noted that these are species having a wide applicability over vast areas within the Empire. Of added interest is the fact that in the case of several of the species the

material under study represents types and strains collected from all parts of the world. A great deal of work has been conducted on the technique of breeding these cross fertile plants. Large populations derived from selfed plants are under review and interesting results have been obtained on cross and self fertility and productivity. In the case of cocksfoot and red clover, a mass of evidence has been collected relative to ecotypical selection, and very instructive living material is at present under study.

Hybridization and genetical work has proceeded some way in respect of red clover, lucerne, the rye-grasses and tall oat grass—while the inter-specific crosses achieved between some of the grasses afford very interesting material for study.

*Herbage Plants : agronomy.*—The ratio leaf to stem of the different species under varied conditions of management is a matter which has received considerable attention ; as has persistency and tiller production. A technique is being developed for studying the relationship between the animal complex (in this case sheep) and the pasture complex, and these studies are being supported by chemical evidence. The fundamental questions affecting the choice of seeds mixtures and putting land down to grass are important topics of study at the Station : matters under review are soil establishment ; the competitive influences of the different species on each other in relation to different systems of management, and the behaviour of different strains of one and the same species in seeds mixtures.

*Cereals : breeding.*—The work has concentrated on endeavours to produce a white and highly hardy winter oat, and good standing varieties of oats suitable for hilly districts and high rainfall. The question of forage oats is also under consideration, and a large number of varieties are under study with a view to subsequent hybridization work. Inter-specific crosses have been made between *Avena brevis* and *A. strigosa* with a view to getting a hardy oat with a better grain character than the latter, and interesting material is under review.

*Cereal diseases.*—In order to try to get an oat of the potato character resistant to crown rust, crosses have been made with the Scotch potato variety (*A. sativa*) and red rustproof (*A. sterilis*), and these too afford interesting material. The effect of bunt fungus of wheat on yield has been studied. The dry treatments (copper carbonate and the like) have been and still are extensively studied at the station.

*Cereals : agronomy.*—These studies are concerned chiefly with yield in relation to (a) early, medium and late varieties at high and low elevations and in sympathy with climatic conditions ; (b) in relation to the source of origin of the parent seed and the conditions under which the seed was grown and harvested.

*Physiology.*—Work has been in progress for the last three years with reference to the effect of the duration of daylight on the

flowering and fruiting of plants. These studies have special relation to the question of the hybridization of strains which do not normally flower together.

Critical studies are being initiated during the present season bearing upon the action of nitrogenous fertilisers on plants kept more or less continuously defoliated ; a large number of plants will be under review during the current season.

A large number of herbage trials are conducted on farms in the district, many of which are within easy motoring distance of Aberystwyth. A number of trials are also carried out in conjunction with the Agricultural Department at the College Farm (Nantcellan), distant 3 miles from the laboratories.

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(7) SCOTTISH SOCIETY FOR RESEARCH IN PLANT BREEDING.

The Scottish Plant Breeding Station is situated near Corstorphine, Midlothian, and is about four miles distant from the General Post Office, Edinburgh. The nearest railway Station is Corstorphine, L.N.E.R., distance about  $1\frac{1}{2}$  miles. *Telephone*: Corstorphine 81.

**Staff.**

<i>Director of Research</i> ..	William Robb, N.D.A.
<i>Chief Assistant (Potatoes and Herbage Plants)</i> ..	Jas. W. Gregor, Ph.D.
<i>Assistant (Potatoes)</i> ..	William Black, B.Sc.
<i>Assistant (Swedes and Turnips)</i> .. ..	V. E. McM. Davey, B.Sc.

**Aims of the Society.**

The aims of the Society are to establish a thoroughly equipped station and to promote the discovery and the creation of such new and improved races of the leading crop plants as are best suited to Scottish conditions.

The methods employed at the Station to obtain improved types of plants are, in the main :—

- (a) Collection and classification of suitable living material.
- (b) Isolation of pedigree strains, pure lines.
- (c) Hybridisation of pedigree strains, varieties, and species.
- (d) Comparative trial of varieties, pedigree strains, &c.

**Summary of Work.**

Plant breeding experiments are being carried out with oats, potatoes, herbage plants, swedes and turnips.

*Oats*.—The main objects of the breeding experiments with oats are (a) to evolve improved types or strains of the old-established and well-known Scottish varieties, namely, Potato, Sandy, and Tam Finlay, (b) to evolve stiff-strawed varieties of oats which will not lodge readily on rich soils.

With the object of obtaining the desired improvements, a few selected varieties have been hybridised with other varieties possessing certain desirable characteristics. Progenies of the hybrids are being studied and observations made on the hybrids with reference to the segregation of various characters. Single plants apparently approaching the desired ideal are selected from among the hybrids of the second and succeeding generations until types breeding true, for the essential characters at least, are separated out.

The first comparative trials are carried out in "centgener" and "rod-row" plots. Further trials of promising selections are carried out in small field-plots before any selection is multiplied on a large scale for field trials in different localities.

*Potatoes.*—The main objects of the breeding work are (*a*) to obtain new varieties, ripening at desired periods, immune from wart disease, resistant to, or if possible immune from, virus diseases, and possessing other desirable characteristics which will commend them to both the grower and the consumer; (*b*) to study the mode of inheritance of various characters of importance in raising new varieties.

The potato breeding experiments are being carried out at two different centres—the breeding of seedlings at the Society's Sub-Station, near Kirknewton, Midlothian, and the field-trials of selected seedlings at the Plant Breeding Station, Corstorphine. The object in raising the seedlings at the Sub-Station is, if possible, to grow them in a district within easy reach of the Plant Breeding Station, where less infection from virus diseases might occur than at Corstorphine, and thus enable more accurate information to be obtained regarding the characteristics of all the seedlings.

Experiments have been started with the object of studying the effects of inbreeding. Observations are being made on the inheritance of immunity from wart disease and on the inheritance of resistance to virus diseases in certain hybrids.

*Herbage Plants.*—The chief object of the work with grasses is to isolate better pasture strains of perennial ryegrass, cocksfoot, and timothy. As a preliminary step towards obtaining improved strains, plants of various types of perennial ryegrass, cocksfoot, and timothy have been selected mainly from populations of plants growing on uncultivated ground in various districts in Scotland. Some of these plants have been hybridised, and the progenies are being studied. The method of breeding which is being pursued is that of hybridising plants similar in form (phenotypes), and preferably from the same population. In connection with the breeding of grasses, investigations are being carried out regarding the occurrence of self-sterility and partial self-fertility. The inheritance of certain characteristics in perennial ryegrass is also being studied. Comparative trials of certain strains of perennial ryegrass raised at the Station are being carried out in small field-plots.

*Swedes and Turnips.*—The work with swedes and turnips, which has for its ultimate object the production of improved varieties, is for the present concentrated mainly on the production of pure breeding strains of swedes by inbreeding, and on devising suitable methods of selecting parent roots.

Experiments are being carried out with the object of ascertaining the mode of inheritance of such characteristics as shape of the "root," skin-colour of the "root," and dry-matter content. Comparative

yield-trials of a few strains breeding true for certain characteristics are now being carried out.

A few apparently healthy "roots" were selected about three years ago from a field crop which was badly infected with finger-and-toe disease. These "roots" were selfed, and breeding experiments are being undertaken to determine whether by inbreeding and selecting throughout a number of generations "roots" immune from, or possessing an increased degree of resistance to this disease, may be evolved. The results so far obtained are encouraging and indicate that the effects of further inbreeding should be studied.

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THE PLANT-BREEDING RESEARCH DIVISION:  
MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

This Division is situated at Stormont, Strandtown, 5 miles from Belfast on the Dundonald tramway line.

**Staff.**

<i>Head of Division</i>	.. Ian W. Seaton, B.Sc.
<i>Assistant ..</i>	.. E. V. B. Wilson, B.Sc.

*Aims of the Division.*

This Division is concerned with the production of improved varieties of the agricultural crops of Northern Ireland, of which the most important are oats, potatoes, flax, roots and ryegrass. Oats annually occupy the greatest acreage, and consequently most time hitherto has been devoted to this crop. The results aimed at in work on oats are :—

- (1) Improvement upon existing varieties as the outcome of breeding work. It is hoped that improved yields may result from the introduction of new varieties produced by the Division. Characters being particularly studied in this connection are :—

Winter hardiness in relation to grain colour.  
Tillering capacity.  
Earliness of maturity.  
Strength and quality of straw.

- (2) The determination of the most suitable existing varieties by variety trials. It is found that there is considerable variation in this respect from district to district, which variation is probably to be correlated with varying climatic conditions. This necessitates the identification of the environmental conditions which influence this variation within varieties. The practical result hoped for here is that improved yields may be obtained by the intelligent "fitting" of varieties to districts.

In flax the objectives are improved yield and quality of fibre.

## (9) NATIONAL INSTITUTE OF AGRICULTURAL BOTANY.

The Offices, the Official Seed Testing Station for England and Wales, and the Headquarters Trial Ground are situated on the Huntingdon Road, 3 miles from Cambridge Station (L.N.E.R.), and can be reached by a frequent service of buses, Service No. 1 from the Station to Market Street and No. 2 from Market Street to the Institute. *Telephone*: Cambridge 1001.

The Institute also has a Potato Testing Station at Lathom Lane, Ormskirk, Lancs., the nearest Station (1 mile) being Ormskirk (L.M.S.R.), with frequent trains from Liverpool, Southport and Preston.

There are also sub-stations for field trials at Sprowston, nr. Norwich; Good Easter, nr. Chelmsford; Long Sutton, nr. Basingstoke; and Leegomery, nr. Wellington, Salop.

## Staff.

<i>Director</i> : W. H. Parker, M.C., M.A... ..	Administrative and Crop Improvement Work.
<i>Secretary and Assistant Director</i> : F. C. Hawkes, M.A. .. .. .. ..	
<i>Manager of Field Plots</i> : S. F. Armstrong, M.A. .. .. .. ..	Crop Improvement Work.
<i>Chief Officer, Official Seed Testing Station</i> : A. Eastham, D.S.O., M.C., B. Sc. ..	Seed Testing.
<i>Assistant to Chief Officer</i> : C. C. Brett, M.A... ..	
<i>Assistant to Chief Officer</i> : R. A. Finlayson ..	
<i>Superintendent of Potato Trials</i> : H. Bryan, B.Sc. .. .. .. ..	Potato Trials and Diseases.

## Aims of the Institute.

The Institute's aim is to improve the yield and quality of farm crops. It is organised for this work in three main branches :—

- (a) Crop Improvement Branch, which affords facilities for the field testing of old and new varieties of agricultural plants and the marketing of new ones.
- (b) Official Seed Testing Station for England and Wales, which tests seeds for purity and germination, examines seeds for certain diseases, and undertakes research work in connection with seed problems.
- (c) Potato Testing Station, Ormskirk, where wart disease immunity trials, yield and maturity trials, and virus disease investigations are carried out, and varieties growing on the trial plots are examined for "synonymity."

## Summary of Work.

### Crop Improvement.

The main work of the Crop Improvement Branch is to provide agriculturists with authoritative reports on the yield and quality of old and new varieties of the principal farm crops, and on their suitability for the various soils and climatic conditions of England. The present trials, begun in 1924, cover wheat, oats, barley, beans, mangolds, swedes, sugar beet and lucerne—some fifty varieties in all. The trials take place at Cambridge and five sub-stations, chosen to represent different soil and climatic conditions. In view of the vagaries of the English climate it is usually necessary to retain each variety in the trials for three seasons, but as soon as enough has been learnt about any variety its place is taken by a newcomer. In this way the merits and defects of all the leading varieties of the present day and the new productions of plant breeders will gradually be registered for the public benefit.

To determine the relative yielding capacities of the varieties a method of field trial devised by Dr. E. S. Beaven is used. This secures the required degree of accuracy without departing from normal methods of cultivation; and as there is at least a quarter of an acre of each variety, the method provides reliable data on such points as strength of straw or disease-resistance under field conditions. Quality is determined by laboratory analyses and practical tests—The National Association of British and Irish Millers mill and bake the wheats, and the Institute of Brewing malt the barleys.

Arrangements are now being made in Essex to give a wider application to the results of these trials by collecting records from farmers of the behaviour of the same varieties under ordinary agricultural conditions.

If a new variety is proved by the trials to be of outstanding merit, the Institute will, where the breeder wishes it, undertake to launch it on the market. Thus in 1924 the Institute marketed through the seed trade a large bulk of an improved wheat, Yeoman II, from the Cambridge Plant Breeding Institute.

Of the minor activities of the Crop Improvement Branch the most interesting to visitors is the collection of cereals, some four to five hundred of which are grown every year at Cambridge.

### Official Seed Testing Station for England and Wales.

The primary duty of the Station (which is managed by the Institute for the Ministry of Agriculture and Fisheries) is to test in the laboratory for purity and germination samples of seeds sent by merchants to enable them to comply with the Seeds Act, or by farmers who wish to check for themselves the quality of the seed they propose to sow. The Seeds Act provides that in the case of the principal kinds of agricultural seeds the seller shall declare the proportions of pure and viable seed and the presence of any injurious weed seeds

there may be in the bulks that he is offering for sale. Many of the larger merchants are licensed to test their own stocks, but the Station receives from 22,000 to 25,000 samples a year. These include some 2,000-3,000 control samples taken by inspectors of the Ministry of Agriculture to check the accuracy of the work of the private licensed stations.

A number of special investigations into the problems that arise from seed testing are always in progress. Some are directed to solve difficulties in the technique of seed testing, others to discover what deductions of immediate value to farmers and seed merchants can be drawn by examination from different points of view of the mass of material that passes constantly through the Station. All serve to swell the store of specialised information on which increasing calls are made by other research workers, seed testing stations, farmers and merchants. Among the subjects now under investigation are the rate at which seeds lose their vitality under different conditions of storage; the relation of laboratory tests to germination in the field; the value of "hard" seeds, broken seeds, and broken growths; improved methods for germination tests of various classes of seeds; means of identifying some of the finer grass seeds; the causes for the rapid deterioration of New Zealand Dogtail and Chewings Fescue during the sea voyage; means of distinguishing wild from Dutch White Clover seed; and the prevalence of seed-borne diseases and the improvement of preventive methods. The last is a subject of growing importance, and the Station already undertakes, as a matter of routine, examinations of wheat samples for the presence of bunt spores, peas for marsh-spot, and celery seed for leaf-spot.

A four weeks' course of instruction and an examination in seed testing are held at the Station every summer.

### Potato Testing Station, Ormskirk.

At its Potato Testing Station the Institute conducts annually for the Ministry of Agriculture trials of new potato varieties for immunity from wart disease. To be certified as immune a variety must be grown at Ormskirk and remain free from wart disease for at least two years. A small entry fee is charged and some 250 plots are grown in infected soil every year. The field plots are now supplemented by greenhouse tests on lines suggested by the Rothamsted Experimental Station.

Wart disease trials in miniature—the "Susceptibility Trials"—are undertaken without fees to meet the needs of students of genetics and breeders. Entries vary from 600 to 2,000.

Virus disease investigations nowadays bulk largely in the Station's programme. In 1927 they consist of:—

- (a) The relative susceptibility to leaf-roll of stocks of six popular varieties from several districts; and the possibility

of combined trials for resistance to virus diseases and wart disease.

- (b) The possibility of growing virus-free seed over a period of years under Lancashire conditions.
- (c) The possibility of building up a healthy stock from a diseased variety.
- (d) Demonstration plots of virus diseases.

Other work at Ormskirk includes the trials for the Lord Derby Gold Medals—these are awarded to new immune varieties of outstanding promise—yield and maturity trials of the leading main crop varieties—these are repeated in Lincolnshire and Cornwall—; “early bulking” trials; and demonstration plots of all varieties that interest British growers.

All the stocks sent for trial to Ormskirk are examined twice each year by the Potato Synonym Committee, who report which are new and distinct varieties and which are only old varieties masquerading under new names.

(10) SEED TESTING AND PLANT REGISTRATION STATION: BOARD OF AGRICULTURE FOR SCOTLAND.

*Location.*—East Craigs, Craigs Road, Corstorphine, Edinburgh.

*Postal Address.*—East Craigs, Corstorphine, Midlothian.

*Nearest Railway Station.*—Corstorphine—L.N.E.R.— $1\frac{1}{2}$  miles.

*Nearest Tram Terminus.*—Corstorphine, 1 mile.

*Telephone:* Corstorphine 83.

#### Staff.

*Director .. ..* Thomas Anderson, M.A., B.Sc. (Agric.)  
Edinburgh. Agricultural Botanist.

*Chief Assistant, Seed Testing Station ..* George Gilray.

*Inspector(attached)(Supervisor of Potato Experiments)* Adam Millar, B.Sc. (Agric.) (Edin.).

*Assistants .. ..* { Rachael K. Stoddart.  
Charlotte G. Simpson.

*Farm Manager .. ..* James Mitchell, B.Sc. (Agric.) (Aberdeen).

#### Summary of Work.

The work of the Station consists of :—

(1) routine work arising from—

(a) the commercial control of seeds and plants which are peculiar to Scottish agriculture, especially the statutory control imposed by the Destructive Insects and Pests Acts, and the Seeds Act, and

(b) the comparison of new breeds of agricultural produce under the Board of Agriculture Scheme of registration of new varieties of agricultural products.

(2) investigations arising out of (1) (a) and (b) above.

#### Seed Testing Station.

(1) *Routine.*—The routine work consists in the testing of approximately 9,000 samples of seeds annually; in giving incidental advice on these samples, and in the development of seed-testing apparatus especially with a view to time saving.

(2) *Investigation Work.*—This is carried out as time permits and consists in analyses of samples of grasses and clovers in the growing state. The Station is specially concerned at present with investigations on methods of proving the authentic character of samples of wild white clover.

## Registration Station.

### (1) Routine Work.

(a) *Potatoes*.—New varieties of potato are tested for immunity from wart disease. Field trials are conducted of new varieties of potato offered for registration as distinct and improved varieties.

Observations are made on the behaviour of potato varieties with a view to obtaining information to predict probable market value of seedlings in the first five years of their existence, firstly as regards yield, secondly as regards diseases (particularly virus diseases). The observations are quantitative and qualitative, intensive and extensive.

(b) *Cereals*.—Field trials are carried out of new and selected varieties, and strains of cereals offered for registration.

### (2) Investigational Work.

(a) *Potatoes*.—Immunity testing has been developed in the laboratory, during the winter months, on a scale equivalent to a field scale. Experimental observations have been made on the validity of methods of field testing; and on the distinguishing characters of potato varieties for the practical purpose of maintaining pure stocks of varieties.

(b) *Cereals*.—Observations have been made on the distinguishing characters of oat varieties. Analyses have been made of cereal varieties, especially those which are peculiarly Scottish.

### (3) Projected Work. *Virus diseases of the Potato.*

It is intended to investigate methods of determining the relative and absolute susceptibility of new varieties; to carry out investigations in brown spotting and necrosis of potato leaves; and experiments on the commercial practicability of building up virus-free or healthy stocks of varieties of the potato.

(11) SEED TESTING AND PLANT DISEASES DIVISION:  
MINISTRY OF AGRICULTURE, NORTHERN IRELAND

This Division is stationed at The Queen's University, Belfast.

**Staff.**

*Head of Division..* .. S. P. Mercer, B.Sc. (Agric.) Lond.,  
N.D.A.

*Chief Assistants :—*

*Plant Diseases* .. A. E. Muskett, B.Sc., Lond., A.R.C.Sc.  
*Economic Botany* .. D. Clouston, M.A., B.Sc., Edin.

**Summary of Work.**

The chief problems under investigation in this Division are as follows :—

**Plant Diseases.**

**I. Potato Diseases.**

A study of Ordinary or Late Blight (*Phytophthora infestans*, de Bary) in Northern Ireland with particular attention to the following points :

- (1) The most economical strength of Burgundy Mixture.
- (2) The number of sprayings necessary to ensure the best results.
- (3) The susceptibility or resistance to the disease shown by varieties lately introduced.
- (4) Spraying *versus* dusting.
- (5) The way in which the disease is carried over from sea on to season.

**II. Flax Diseases.**

Studies of the causal fungi, and methods of control. Seedling Blight (*Colletotrichum linicolum*, Pethy. & Laff.) and Browning or Stem Break (*Polyspora lini*, Laff.)

**III. Fruit Diseases and Pests.**

**A. Apples.**

1. *Frost Injury*.—An enquiry is in progress upon orchard heating as a preventive measure against damage to blossom by spring frosts.

2. *Apple Sucker and Greenfly*.—A series of comparative trials with tar distillate washes (applied in winter) to determine their relative efficiency in controlling these pests is almost complete.

3. *Apple Scab* (*Venturia inaequalis*, Aderh.).—During recent years scab has perhaps been the greatest obstacle to apple growing in Northern Ireland. Full investigations, both in the laboratory and in

the field are being made with regard to this disease and its control. The following are some of the points under consideration :—

- (a) The most suitable strength of Bordeaux Mixture.
- (b) Bordeaux Mixture compared with Burgundy Mixture.
- (c) The importance of early spraying.
- (d) Varietal susceptibility to disease and to spray injury.

4. *Apple Capsid*.—Field experiments are in progress with regard to control measures for this pest, which has already become well established in County Armagh.

#### B. Gooseberries.

*American Gooseberry Mildew* (*Sphaerotheca mors-uvae*, Berk).—Very satisfactory results have been obtained from experiments relating to the control and a report has been published. Further experiments are in progress.

#### IV. Forestry Diseases.

A full investigation of methods to prevent the damping off of Sitka Spruce and Douglas Fir Seedlings caused by parasitic fungi has been tested with satisfactory results. A record of these is being prepared for publication.

#### V. Celery Leaf Spot (*Septoria apii* Bri. & Cav.).

An investigation concerning the prevention and control of this disease is in progress.

### Seeds and Crops.

#### I. Seeds.

Seed production (chiefly from ryegrass) constitutes an important industry in Northern Ireland, the annual output being in the neighbourhood of thirty thousand tons. Problems affecting production and export are therefore of special moment. Investigations are in progress on the following lines :

- (a) *Seed Growing*.—The effects of (i) Strain of seed, (ii) Manuring, (iii) Constitution of mixture sown, (iv) Maturity at harvest, (v) Methods of curing and (vi) Methods of storage form the subjects of separate experiments. Results so far accrued indicate that manuring does not usually affect quality of seed produced, or speed of maturation, but may influence keeping quality under poor storage conditions. Preliminary experiments upon date of cutting suggest that germination capacity of produce is not nearly so much affected by maturity at harvest as is usually supposed, but bushel weight may be seriously affected. On the other hand the quality of hay is obviously improved and probably that of ensuing pasture.

- (b) *Shipping*.—Experiments with ryegrasses over five years show that loss of germination during shipment is not usually uniform throughout a parcel and appears to depend on the heat : moisture : time ratio of the voyage. Tropical passages seriously enhance the damage. Contents of bags may rise during shipment through Panama to a temperature of 33° C., with loss in germination ranging up to 20 per cent. Reduction of damage by ventilation and refrigeration is being attempted.
- (c) *Seed Testing*.—Experiments are being pursued with regard chiefly to :
- (i) *Lethal temperatures*.—In testing ryegrass by routine methods, the third day on the germinator seems to be the crucial period, and the critical temperature about 40°C.
  - (ii) *Sampling methods* in laboratory and warehouse. Preliminary results indicate that modification of current mixing and drawing methods is desirable. This investigation is under the ægis of the International Seed Testing Association.
  - (iii) *Effect of atmospheric conditions* upon accuracy of tests has been found much larger in a damp climate than was supposed. In twenty-four hours, ryegrass exposed in a warm room may vary 3½ per cent. in weight and in a few days nearly 8 per cent. A short report on this point has been published.

## II. *Crops*.

*Biology of grasses*—*Alopecurus pratensis* and *Lolium perenne* are subjects at present under observation. In the former the chief enemy to seed production in Britain seems to be the Gall Midge (*Oligotrophus Alopecuri*, Reut.) whose life history is being studied and methods of control contrived. *Lolium perenne* shows remarkable variation and some of its variants conspicuous longevity. Strains are being segregated. Preliminary reports have been published upon *Alopercurus*.

Extensive trials have been laid down to compare commercial strains of Wild White Clover.

## B.—Horticulture.

### (12) LONG ASHTON FRUIT RESEARCH STATION : UNIVERSITY OF BRISTOL.

*Situation.*—Long Ashton, nr. Bristol.

*Railway Stations.*—Temple Meads Station (L.M.S. and G.W.R. Joint), Bristol, 4 miles. The Research Station is within easy reach of this station by tramcar from Temple Meads to Framway Centre (1d. fare), thence by 'bus to the Research Station, Long Ashton (5d. fare).

Flax Bourton Station, G.W.R., 1 mile. Local train service only. Occasional 'buses pass Station to Research Institute. *Telephone:* Long Ashton 15.

#### Staff.

<i>Director</i>	..	..	Prof. B. T. P. Barker, M.A., (Cantab.)
<i>Deputy Director</i>	..	..	T. Wallace, M.C., M.Sc. (Dunelm), A.I.C.
<i>General Chemistry</i>	..	..	T. Wallace, M.C., M.Sc. (Dunelm), A.I.C.
<i>Bio-Chemistry</i>	..	..	F. Tutin, M.Sc. (Bristol).
<i>Entomology</i>	..	..	A. H. Lees, M.A. (Cantab.)
<i>Mycology</i>	..	..	R. W. Marsh, M.A. (Cantab.)
<i>Plant Physiology</i>	..	..	Vacant.
<i>Pomology</i>	..	..	G. T. Spinks, M.A. (Cantab.)
			J. G. Maynard, M.A. (Cantab.) Dip. Hort. (Cantab.) Plantations Officer.
<i>Cider</i>	..	..	O. Grove, M.Sc. (Bristol).
<i>Willow Officer</i>	..	..	H. P. Hutchinson, B.Sc. (Lond.)

#### Aims of the Station.

The work of the Station has as its object the investigation of problems relating to (*a*) Fruit culture, (*b*) Diseases of horticultural crops—more especially of fruit crops, (*c*) Fruit preservation and products—including cider making and ordinary and cold storage of fruits, (*d*) Willow cultivation and the utilisation of osiers in rural industries.

The Station also functions as an advisory centre for problems relating to these subjects.

In accordance with the aims of the Station the problems under investigation may be grouped conveniently under the headings (*a*) Fruit culture, (*b*) Pests and diseases and their control, (*c*) Fruit preservation and products, (*d*) Willow culture and the utilisation of willows. The Station is well equipped for these various lines of investigation. There are laboratories fitted for all branches of the work, greenhouse accommodation is available for indoor experiments with plants, and facilities are provided for pot culture work. There is also a cider factory equipped with modern appliances for cider making, and a cold store.

Adjoining the buildings is the farm, embracing some 257 acres, of which about one-half is suitable for experimental work on fruit. At the present time approximately 100 acres are occupied with experimental fruit plots.

A willow bed has been established, in which 108 varieties are being grown for the purposes of investigation and demonstration.

### **Summary of Work.**

The main problems under investigation at the present time are as follows :—

#### *1. Fruit Culture.*

##### *(a) Investigations on Tree Fruits.*

The largest section of the work under this head relates to the numerous problems which arise in connection with the nutrition of fruit trees. In this section of the work are included (a) root stock problems, (b) factors determining the relation of growth and fruit bud formation, (c) manurial experiments, (d) functional diseases due to defective nutrition, (e) the action of rain on foliage.

(a) In the work on root stocks attention is being given to the so-called "free" and "crab" stocks of the apple. In connection with the former a series of stocks capable of propagation by layering methods has been selected with the object of finding stocks of sufficient vigour to serve for the raising of standard trees for orchard purposes and at the same time to be suited for multiplication vegetatively so that the present want of uniformity due to the use of seedling stocks of varying vigour can be avoided.

(b) The investigations under (b) are very varied. The more important deal with the relationships between (i) stock and scion and (ii) the root and shoot growth; the character and movement of food reserves in relation to growth; fruiting and disease resistance; the response to pruning methods.

(c) Problems of the manuring of fruit trees are attacked by laboratory, pot culture and field methods. The field experiments are not confined to the Station plots, many being carried out in commercial plantations where definite problems exist.

(d) Of the functional disorders leaf scorch and chlorosis have so far received special attention and the investigations on these have reached advanced stages.

Closely related to the above investigations on nutrition is the survey work on the soils of fruit-growing areas which is in progress. These surveys are designed to establish the relationships which exist between various soil conditions and the growth of fruit trees. The results so far obtained indicate the great importance of this line of work to the fruit grower on account of the help afforded in the selection of soils suited to fruit culture.

(b) *Investigations on Soft Fruits.*

Considerable attention is given to problems relating to the various soft fruits—strawberries, raspberries and loganberries, black currants, red currants and gooseberries.

*Strawberries.*—In the case of strawberries an exceedingly comprehensive programme of work is in course of progress. Investigations on a large scale on this fruit have been undertaken in view of the serious condition which exists in the industry to-day, which appears to be mainly due to the widespread occurrence of a devastating deterioration in the quality of the plants, the causes of which have hitherto been undetermined.

The programme includes the study of the life cycle of the strawberry plant, problems of varieties, strains, propagation methods, cultural methods, nutrition, diseases and abnormal plant forms. Considerable progress has been made along certain of the lines of work and in the immediate future attention will be devoted mainly to the study of the diseased forms associated with the more serious commercial failures.

*Raspberries.*—The main feature of the work on raspberries is the carrying out of a scheme of variety trials in conjunction with the East Malling station. Pure lines of these varieties have now been established as the result of preliminary systematic selection.

*Currents.*—Work is proceeding on the identification and classification of red currant varieties, about which relatively little is known at present.

In the case of black currants the study of problems relating to the propagation from cuttings is in progress.

*Gooseberries.*—The work on gooseberries is also chiefly concerned with the sorting out of pure lines of the varieties and the problems of variety classification.

(c) *Fruit Breeding.*

Fruit breeding takes an important place in the Station programme and several acres of the plantations are occupied by seedlings of tree and bush fruits bred at the Station. The work is chiefly confined to apples, plums, pears, black currants, various Rubi and strawberries.

The work on black currants has reached a fairly advanced stage and several promising selections have been propagated on a fairly large scale, whilst with apples and plums the individual seedlings have now reached the cropping stage.

2. *Pests and Diseases of Fruit and their Control.*

In this branch of the Station's activities it is necessary for the workers concerned to give general attention to pests and diseases which from time to time inflict serious damage in the fruit plantations of this country. There are, however, certain pests and diseases and

certain problems relating to spray fluids and other forms of disease control which form the subjects of special study by the pathological staff, and the more important of these are mentioned here.

(a) *Entomological.*

In the entomological department the two important diseases of the black currant—"reversion" disease and "big bud" disease—have been the subjects of elaborate investigations and this work, which is still proceeding, has led to important practical findings.

Other subjects under investigation in this department are Eel-worm disease of strawberries; Strawberry Aphid; control of Capsid Bugs, Pear Midge and Willow pests; and the relation between manurial treatment and susceptibility to insect attack.

A considerable amount of work—both entomological and chemical—has been carried out on tar distillate washes, which were first introduced into this country by the Station and are now largely used as winter washes to kill the eggs of certain destructive insect pests such as apple and plum aphides.

The possibility of utilising certain miscible oils as sprays for spring and summer use is being examined.

(b) *Mycological.*

The main mycological investigations relate to "Die-back" in fruit trees, collar rots of fruit trees—especially *Rosellinia necatrix*, strawberry diseases, crown rots of the raspberry, the control of American gooseberry mildew, and the fungicidal action of sulphur.

In connection with "Die-back" diseases a 5-acre plantation of plum varieties on several different forms of root stocks has been established on the Station grounds.

The work on sulphur forms a very comprehensive study in which the mechanism of the action of this substance in relation to the fungus and the host plant is being examined in detail.

**3. Fruit Preservation and Products.**

Under this section are included cider-making investigations, which are a prominent and unique feature of the work of the Institute; cold storage work on fruits, which is carried on in conjunction with the Food Investigation Board; and chemical studies on the composition of fruits. Much attention has been given to pectin, a constituent of the apple and other fruits, which is of fundamental importance in the jam-making industry.

The field covered in cider investigations is very comprehensive, the programme including a whole range of problems which arise in the production of suitable raw material and in the manufacture of the beverage.

Special attention is at present directed to problems relating to the action of sulphur dioxide as a preservative on apple juice and cider, the utilisation of ungradable culinary and dessert apples in the cider

industry, and the production of ciders of uniform character and free from liability to bacterial disorders by the preliminary pasteurisation of the freshly expressed juice and subsequent fermentation with pure cultures of selected yeasts.

#### *4. Willow Culture and the Utilisation of Willows.*

The programme of work on willows is designed to supply information on any problems which may arise in connection with the growing, marketing and utilisation of willows. It includes investigations on varieties, propagation of sets, cultural treatments, harvesting and preparation of rods for market, control of pests and diseases, and uses of willow products.

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(13) FRUIT AND VEGETABLE PRESERVATION RESEARCH STATION: UNIVERSITY OF BRISTOL.

This Station is situated at Campden in Gloucestershire.

*Railway Station*.—Campden—Great Western Railway.

*Telephone*.—Campden 9.

**Staff.**

<i>Resident Director</i>	.. .	A. Appleyard, M.Sc., F.I.C.
<i>Micro-Biologist</i>	.. .	F. Hirst, A.R.C.S.
<i>Assistant Chemist</i>	.. .	Vacant.
<i>Demonstrator in Food Preservation</i>	.. .	Margaret Adams.

**Aims of the Station.**

Climate and the incidence of disease make a nice adjustment of supplies of fresh fruit to the demand impossible. Considerable fluctuation in yield is incidental to fruit and vegetable culture, and the necessity for developing fresh outlets for produce has been emphasised, especially in recent years. The demand for fruit and vegetables out of season has become thoroughly established, and various forms of preserved fruits have become common articles of food. Moreover, improved methods of marketing involving the grading of produce have brought the growers face to face with the problem of the profitable disposal of the low-grade material which at present constitutes a relatively large proportion of the crop.

For these reasons, the industries associated with fruit and vegetable preservation and products are capable of making a substantial contribution to the prosperity of growers by affording important outlets for produce.

Fruit production in the British Empire is under a very heavy handicap as compared, for instance, with the United States, where the preservation and products industries have been developed on an enormous scale. The Empire—and especially Great Britain—is importing immense quantities of canned and other forms of preserved fruit and vegetables from foreign countries.

The Campden Research Station has been established to carry out research and experimental work on fruit and vegetable preservation and products, and serves as the centre for educational and advisory work on this subject.

**Summary of Work.**

The scope and character of the work being carried out at present are as follows:—

*Research.*

1. Canning of fruit and vegetables with special reference to :
  - (a) Commercial scale trials of soft fruits to determine the best temperatures and times of processing in relation to different sizes of containers, the preservation of colour, and the use of syrups. These experiments are being carried out in conjunction with :
    - i. Littleton and Badsey Growers Association.
    - ii. Herefordshire Fruit Packing Co.
    - iii. Cotswold Canning Company.
  - (b) A commercial scale trial to be conducted in Kent in conjunction with an apple grading and packing scheme under which the economics of apple canning and the utilisation of low grade apples, can in particular be studied.
  - (c) The suitability of different varieties for canning : peas, raspberries, strawberries.
  - (d) The testing of lacquers for use on tinplate for fruit and vegetable containers, in conjunction with Messrs. Williamson & Sons, Ltd., Worcester, canmakers, and Messrs. Holden & Sons, Ltd., Birmingham, lacquer manufacturers.
2. Experiments on the use of sulphur dioxide as an antiseptic in conjunction with various methods of preservation.
3. The preparation and use of fruit juices and syrups.
4. Jam and jelly making at relatively low temperatures, and the use of fruit pectins for fruit preserves.
5. Experiments on the preparation of plum products.
6. Investigations on the bio-chemistry of the "brining" process for the preparation of vegetables for pickling.

*Education.*

1. Courses of instruction in fruit and vegetable preservation : Some five courses of instruction are given annually, each lasting ten days.
2. Extra-mural lectures to Women's Institutes and Young Farmers' Clubs are given during the fruit season.
3. Leaflets on the preservation of gooseberries, raspberries and loganberries, currants, cherries, blackberries, plums and damsons, pears, and on marmalade preparation, have been published for use by the general public.

*Advisory*

The Station undertakes investigations, and furnishes reports on canning and other preservation problems to firms engaged in the preserving industries, and gives technical assistance to the National Food Canning Council.

## (14) HORTICULTURAL RESEARCH STATION, EAST MALLING KENT.

*Nearest Station.*—East Malling Halt—Southern Railway. Or from Maidstone (5 miles) to East Malling Church by 'bus every half hour. *Telephone:* Aylesford 29.

**Staff.**

<i>Director</i> .. .. ..	Ronald G. Hatton, M.A.
<i>Assistant Director</i> .. .. ..	R. C. Knight, D.Sc., D.I.C., of Imperial College of Science and Technology Staff.
<i>Pomology</i> .. .. ..	R. G. Hatton, M.A. N. H. Grubb, M.S.A. W. S. Rogers, B.A.
<i>Statistics</i> .. .. ..	T. N. Hoblyn. (Hort. Dip. Wye).
<i>Plant Physiology</i> .. .. ..	R. C. Knight, D.Sc., D.I.C. M. C. Vyvyan, M.A. (Cantab ).
<i>Bio-Chemistry</i> .. .. ..	W. A. Roach, B.Sc., A.R.C.Sc., D.I.C.
<i>Pathology</i> .. .. ..	H. Wormald, D.Sc., A.R.C.Sc., D.I.C. R. V. Harris, B.Sc., A.R.C.Sc.
<i>Entomology</i> .. .. ..	A. M. Massee, F.E.S.

**Summary of Work.**

The principal subjects under investigation at East Malling may be classified under :—

**I. Researches on Fruit Plants.**

- (a) Pomology.
- (b) Physiology.
- (c) Pathology :
  - (i) Mycological.
  - (ii) Entomological.

**II. Hop Investigations.****I. Researches on Fruit Plants :**

The main lines of work already under investigation and likely to be continued for some years are as follows :—

- (a) *Pomology.*—Activities under this heading include systematic cultural and breeding work. The confusion existing with regard to the naming of horticultural varieties has necessitated preliminary work in identification, selection, description and the raising of pure lines. Such work has already been undertaken both in the cases of the root

stocks upon which fruit trees are grafted, and also with black currants and raspberries. The suitabilities of the different varieties for market purposes are also being studied. New varieties are being raised.

Upon the cultural side, East Malling has set itself to study the effects of various operations upon the plant's individuality. A study of the "build up" of the tree is in progress, and the effects of budding and grafting, of intermediate grafting and of the selection of both root stock and scion are being followed out. This work involves a special study of methods of vegetative propagation and subsequent selection and breeding of desirable types of root stock. Standardisation of the fruitgrower's material, by reducing the variability of fruit plants, is the economic object in view.

The modifications effected by various soils and by different methods of treatment upon the individual are next being followed up. For instance, different methods of planting, manuring and pruning are being studied in relation to the tree as a whole and to particular varieties. The effects of spray fluids upon the tree, apart from their fungicidal or insecticidal value, are being traced.

The cultural programme has as its object the establishment of the best possible plant under the best growing conditions.

- (b) *Physiology*.—A systematic physiological study of the relations between stock and scion is in progress with the double aim of elucidating the mechanism of stock influence, and of characterising stocks from their physiological reactions. Analysis of stock and scion relations is also being attempted in a series of field experiments.

The principles underlying vegetative propagation are being investigated in order to discover methods of multiplying desirable varieties of stocks which are difficult to raise.

The inter-relation of shoot and root growth of fruit plants is being studied, especially in connection with pruning and propagation.

- (c) *Pathology*.—The investigations relate to certain fungal, bacterial and virus diseases and insect pests. One of the most striking manifestations of the plant's individuality is its susceptibility or resistance to disease and its response to remedial measures. The true lines of plants established at East Malling are being used for such studies, both by the Mycological and Entomological sections.

Different varieties of root stocks and soft fruits show varying degrees of susceptibility to diseases and pests. The susceptibility of apple stocks to the permanent apple aphid, the woolly aphid, and crown gall, and of

certain selected cherry stocks to cherry aphid is under especial study.

Resistant plants are being selected or bred and vegetatively propagated for further trial. The effect of different plum stocks upon the incidence on the trees of silver leaf disease, and possible preventive and control measures for that disease in the field, are being worked out.

The possible reaction of different root stocks upon the scions grafted thereon is also being carefully observed in the case of apple mildew, canker and scab. A special study is being made of the susceptibility of raspberry varieties to particular diseases.

Particular attention is also being paid by the Mycological Section to :—

- (1) Bacterial Canker of Plum and Cherry Trees.
- (2) The distribution and control of the Brown Rot Diseases.
- (3) Diseases of Raspberries.
- (4) The control of Apple Scab and Mildew.

The Entomological Section is also specializing upon :—

- (1) The Gall Mites, many of which, especially on the small fruits, are of great importance to the fruit grower.
- (2) The control of the Apple Sawfly.
- (3) The testing of certain egg-killing washes.
- (4) The relation of certain insects on raspberries and the transmission of virus diseases.
- (5) So-called Reversion and its possible transmission by a new species of Mite.

## II. Hop Investigations.

East Malling is growing and drying for chemical analysis and brewing trials leading commercial varieties of hops and a number of new seedlings bred and selected by Professor E. S. Salmon (Wye). Data are being collected as to the weight, ultimate yield, resin contents and market value, as well as disease resistance, of these varieties.

Manurial trials, designed to test not only the effect upon the yield, but also upon the quality of the hops, are also in progress.

Cultural experiments in methods of "cutting," "pulling," &c., have been initiated.

Systematic descriptions are being made of the principal commercial varieties of hop with a view to establishing easy methods of identification and as a preparatory to ultimate selection of good strains.

Various diseases of the hop plant are under investigation.

(15) HORTICULTURAL RESEARCH STATION: CAMBRIDGE UNIVERSITY.

The orchard and experimental grounds of this research station are situated on the University Farm, Huntingdon Road, Cambridge. The nearest railway station is Cambridge. The laboratory is at the School of Agriculture, Downing Street, Cambridge. The Station is under the general control of the Director of the Plant Breeding Institute and a committee representative of fruit and vegetable growers. *Telephone* : Cambridge 569.

**Staff.**

<i>Director</i> .. .. ..	Prof. Sir R. H. Biffen, M.A., F.R.S.
<i>Deputy Director</i> .. ..	D. Boyes, M.A.

**Summary of Work.**

The chief subjects of investigation in progress at present are, amongst fruits, the breeding of improved varieties of apples, pears, plums and strawberries, and amongst vegetables, onions, various brassicae and parsnips. Pruning trials are also being made of a number of well-known varieties of apples on various East Malling stocks, and a series of pears is being grown to test their value for commercial cultivation. A comprehensive series of investigations on the physics of spraying fluids is in progress with the object of securing better wetting and adhesive properties in fungicides and insecticides and more lasting emulsions of various oils used in the control of plant diseases.

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(16) EXPERIMENTAL AND RESEARCH STATION:  
CHESHUNT.

This institute is situated at Turner's Hill, Cheshunt, Herts., in the centre of the Lea Valley Glasshouse district. The nearest railway stations are Cheshunt (12 minutes walk) and Waltham Cross ('bus outside station going to Cheshunt passes the door), both on the L.N.E. Railway from Liverpool Street Station, London. Telephone: Waltham Cross 150.

**Staff.**

<i>Director</i> .. ..	W. F. Bewley, D.Sc.
<i>Entomologist</i> .. ..	E. R. Speyer, M.A.
<i>Chemist</i> .. ..	O. Owen, M.Sc., A.I.C.
<i>Mycologist</i> .. ..	P. H. Williams, B.Sc.

**Aim of the Station.**

The object of the Station is to investigate the many problems which arise during the commercial cultivation of glasshouse crops. Advisory work is an important feature.

**Summary of Work.**

I. *Manurial and crop management trials with tomatoes and cucumbers.*

These are conducted in the experimental glasshouses of the Station, which are constructed on commercial lines. All records are designed to determine the effect of the different treatments upon weight of crop, quality of fruit and resistance to diseases and pests.

The current experiments are arranged to test the following :—

(a) *Tomatoes.*

- (1) The effect of different quantities of stable manure applied before planting.
- (2) The effect of commencing watering at different dates, and of different quantities of water applied at a time.
- (3) The effect of increasing quantities of nitrogen, potash and phosphate; the object being to discover the correct proportion of these nutrients in a good tomato fertiliser mixture.
- (4) The effect of green manuring and fallowing under glass.
- (5) Variety trials are also included.

(b) *Cucumbers.*—Past experience has shewn that failure of the cucumber crop is mainly due to the presence of harmful influences in the base, or soil upon which the beds are placed. The experiments are designed to test different methods of treating the base to remove these factors. The present treatments are mainly concerned with steam sterilisation.

## II. Animal pests of glasshouses.

(a) *Red Spider Mite*.—This serious pest of glasshouse plants has been studied during the past four years. The fumigation of cucumber houses with naphthalene has been used extensively on nurseries with good results.

For tomato-house conditions another fumigant is being sought, but timely spraying with soft soap and liver-of-sulphur in rainwater has prevented serious outbreaks.

A special investigator is making observations on commercial nurseries with a view to preventing attacks by improved methods of hygiene and crop management.

The services of a special chemist are being employed for the study of the action of gases and vapours upon the pest.

(b) *White-fly*.—A Chalcid parasite of white-fly was obtained in July last, and has been successfully reared through the winter, so that a stock of considerable magnitude is available for experimental control by this means.

## III. Diseases of glasshouse plants.

The following are under investigation :—

Mosaic disease of cucumbers and tomatoes.

*Tomato Mildew (Cladosporium fulvum)*.

*Rhizoctonia* foot-rot of the tomato.

The *Diplocarpon* disease of the strawberry under glass.

*Thielavia* root-rot of the tomato.

“ Damping-off ” of the cucumber.

Cucumber root-rot.

## IV.

Investigations to determine if increased crops can be obtained by artificially enriching the air of glasshouses with carbon di-oxide.

Tomatoes submitted to a concentration of 0·06 per cent. carbon di-oxide for one hour daily have given a crop increase of over 25 per cent. above the control.

## V. Chemical Investigations.

An attempt is being made to determine the effect of manorial treatment on the availability of nitrogen in tomato soils. For this purpose, soil samples are taken, weekly, from various experimental plots in both the new and the old houses. These samples are analysed immediately, for moisture, nitrates and ammonia.

## (17) JOHN INNES HORTICULTURAL INSTITUTION.

*Address.*—The John Innes Horticultural Institution, Mostyn Road, Merton, S.W. 19. *Telephone:* Wimbledon 1214.

The laboratories and experimental grounds of about 14½ acres are situated at Merton, Surrey (railway station, Wimbledon).

The John Innes Horticultural Institution was founded in 1910, and derives its income from a Trust fund created by the will of the late John Innes. It is administered under a scheme of the Charity Commissioners by a representative Council appointed by the Royal Society, the Ministry of Agriculture, the Linnean Society and the Royal Horticultural Society and the Fruiterers' Company. The first Director was the late William Bateson, who died in 1926.

**Staff.**

The present Director is Sir Daniel Hall, K.C.B., F.R.S. The scientific staff consists of 13 members:—Dr. E. J. Collins, Messrs. J. B. S. Haldane, W. C. F. Newton, C. L. Huskins, R. J. Chittenden, M. B. Crane, C. D. Darlington, H. D. Bennett, Misses C. Pellew, D. M. Cayley, D. de Winton, I. Andersson, A. E. Gairdner.

**Summary of Work.**

. The main line of work at the Institution is the study of the genetics and cytology of cultivated plants. At present work is in progress on species of *Primula*, *Campanula*, *Antirrhinum*, *Dianthus*, *Nicotiana*, *Pisum*, *Dahlia*, *Avena*, *Triticum*, *Linum*, *Scolopendrium*, &c., &c. Other lines of work are:—chimeras and graft hybrids, sterility in and fertilisation of cherries, plums and apples, the inheritance of disease resistance, &c.

The Institution is open to receive voluntary research workers.

The Institution appoints annually a certain number of Exhibitors, young working gardeners who receive a course of scientific instruction and technical training, while assisting in the routine work of the Institution.

### C.—Animal Pathology.

#### (18) RESEARCH INSTITUTE IN ANIMAL PATHOLOGY: ROYAL VETERINARY COLLEGE, LONDON.

The Institute occupies a site close to that of the Royal Veterinary College, in Great College Street, Camden Town, a short distance from St. Pancras Town Hall. The nearest railway station is Mort-  
ington Crescent on the Hampstead Tube Railway. Its distance from St. Pancras and King's Cross Station is about half a mile. Telephone: North 1703.

#### Staff.

<i>Director of Research</i>	.. F. C. Minett, B.Sc., M.R.C.V.S.
<i>Principal Assistant</i>	.. A. Leslie Sheather, D.Sc., M.R.C.V.S.
<i>Senior Assistants</i>	.. A. D. McEwen, B.Sc., M.R.C.V.S. A. W. Stableforth, B.Sc., M.R.C.V.S., D.V.S.M.

#### Aims of the Institute.

The function of the Institute is to endeavour to extend knowledge regarding the diseases of the domesticated animals, especially in the direction of causation and prevention. The Institute is in close touch throughout the country with veterinary surgeons and stockowners, and the diseases from time to time selected for investigation are those that appear to be of the greatest importance from an economic point of view. Those that have been the subject of most prolonged research are abortion in cows and mares, arthritis in foals, Johne's disease, mastitis in cows, parasitic gastritis in ruminants, and quartet-evil in cattle.

#### Summary of Work.

*Epizootic Abortion in Cows.*—The work in connection with this disease was a continuation of that carried out under the Committee appointed by the Board of Agriculture in 1905, and in the first place it was directed to exploring the value of the agglutination test for the diagnosis of the disease. Through the agency of the Royal Agricultural Society and practising veterinary surgeons the Institute was placed in connection with owners of infected herds who were willing to have the whole of their breeding animals tested.

As soon as experience had proved the accuracy of the test attempts were made in various infected herds to eradicate the disease by carrying out repeated tests and isolating the animals thus found to be infected. It was soon found that this method was liable to failure when an attempt was made to isolate the infected animals or the

same premises as the healthy. It was shown, however, that even badly infected herds could quickly be freed from the disease when the affected animals could be removed to premises at some considerable distance from those in which the healthy portion of the herd remained.

Other important facts that emerged from the researches were :—

- (1) That although young cattle can readily be infected with the disease those under breeding age usually make a complete natural recovery :
- (2) That in breeding animals on the contrary a speedy recovery is quite exceptional, many cows remaining infected for years and presumably remaining capable of spreading the disease.

The observations made in infected herds showed that in many cases from 30 to 50 per cent. of the cows were infected. Tests also showed that a small proportion of bulls were infected, but observations made in infected herds did not indicate that the bull played a part of any importance in the infection of the cows.

*Abortion in Mares.*—Any form of contagious abortion in mares appears to be comparatively rare except in thoroughbred studs, and the researches of the Institute have shown that the most frequent cause is the *Bacillus abortivo-equinus*, but in a few cases streptococci or coliform bacilli have been found.

The widest possible publicity has been given to the fact that the Institute wishes to be consulted when cases of abortion in mares occur, and that assistance in diagnosis and advice with regard to the best method of treating an outbreak will be given. It is believed that killed cultures of the causal bacilli might be used without danger to confer immunity on mares, but it has not been found possible to induce owners to allow the method to be tried.

*Joint-ill in Foals.*—The researches with regard to what is generally called joint-ill in foals have shown that the name covers a number of infections caused by distinct species of bacteria. All the information obtained indicates that about 60 per cent. of the cases are caused by streptococci, and that the disease is not contracted otherwise than by infection at the navel immediately after birth. In three successive foaling seasons serum and a vaccine composed of killed streptococci were supplied gratis to veterinary surgeons. Where possible vaccine was to be given to mares before foaling and to the foal immediately after birth. The information collected with regard to the use of the serum and the vaccine indicated that neither had any effect in reducing the incidence of the arthritis or the mortality among the foals attacked.

*John's Disease.*—This disease has been studied particularly with regard to the cultural and other characters of the causal bacillus, the symptoms and duration of the disease, the appearance and

histology of the lesions, the transmissibility of the disease, its natural occurrence in different species of animals, the period of incubation, and treatment. Full publicity has been given to the fact that owners of infected herds can obtain the assistance of the Institute in dealing with outbreaks.

*Mastitis in Cows.*—The researches with regard to mastitis were directed in the first place to determining the species of bacteria found in the diseased udder, and it was found that streptococci occupy the first place in respect of frequency, and the *Bacillus pyogenes* the second. Vaccine prepared from both these organisms has been supplied on demand to veterinary surgeons.

*Parasitic Gastritis in Ruminants.*—The investigations have shown that it is the smaller species of nematode worms that are the principal cause of the disease in this country, the *Haemonchus contortus* being only exceptionally the cause of trouble. An extensive trial has been made of the drugs that have been in general use in the treatment of the disease, and not one of them has been found to be effectual in killing the smaller stomach worms (*Ostertagia circumcincta*, *Trichostrongylus extenuatus*, *Trichostrongylus instabilis*, and *Trichostrongylus vitrinus*).

*Quarter Evil.*—A study has been made of the morphological and cultural characters of the causal bacillus, the *B. chauvæi*, and a new method of cultivating that and other anaerobic organisms in liquid media has been discovered. A vaccine has been prepared which in respect of safety and efficacy appears to be superior to any hitherto employed to immunise young cattle against the disease. It has been distributed to veterinary surgeons to ascertain its value in the field.

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(19) INSTITUTE OF ANIMAL PATHOLOGY:  
CAMBRIDGE UNIVERSITY.

The Institute of Animal Pathology is an independent unit occupying its own buildings and lands adjoining the original University Field Laboratories at Milton Road (the Cambridge—Ely main road). The distances from the town railway station and from the Market Place are some  $3\frac{1}{2}$  miles and 2 miles respectively. *Telephone*: Cambridge, 639.

The Institute was established in 1923, and a staff formed without delay, but work had to be carried out in temporary quarters at the Field Laboratories and at the Medical Schools until the completion of the Institute's own buildings in the summer of 1926, enabled the Staff to occupy their new quarters. A central unit in the University, which will be part of the new School of Pathology, is still in the hands of the builders. It is anticipated that this scheme of centralising the two branches of pathology will facilitate collaboration and materially increase the value of the comparative study of disease.

**Staff.**

<i>Director</i> .. .. ..	Professor J. B. Buxton, M.A., F.R.C.V.S., D.V.H., Professor of Animal Pathology at Cambridge University.				
<i>Assistant Director and Pathologist</i>	T. J. Bosworth, B.Sc., M.R.C.V.S., D.V.S.M.				
<i>Protozoologist</i> .. .. ..	A. P. Jameson, D.Sc.				
<i>Pathologists</i> .. .. ..	<table border="0"> <tr> <td>R. E. Glover, B.Sc., M.R.C.V.S.</td> </tr> <tr> <td>R. L. Cornell, B.Sc., M.R.C.V.S.</td> </tr> <tr> <td>W. J. Leyshon, M.R.C.V.S.</td> </tr> <tr> <td>J. R. Innes, M.R.C.V.S.</td> </tr> </table>	R. E. Glover, B.Sc., M.R.C.V.S.	R. L. Cornell, B.Sc., M.R.C.V.S.	W. J. Leyshon, M.R.C.V.S.	J. R. Innes, M.R.C.V.S.
R. E. Glover, B.Sc., M.R.C.V.S.					
R. L. Cornell, B.Sc., M.R.C.V.S.					
W. J. Leyshon, M.R.C.V.S.					
J. R. Innes, M.R.C.V.S.					
<i>Chemist</i> .. .. ..	J. Stewart, M.A., B.Sc.				

**Aims of the Institute.**

The work of this Institute consists almost entirely of investigations into the diseases of farm animals. In order that this may be effected as economically as possible, liaison is maintained with veterinary practitioners, agricultural organisers and stockowners. In addition a department has been created which deals entirely with the routine diagnosis of pathological material sent in by veterinary surgeons and stockowners, while the agricultural organisers keep the Institute informed of serious outbreaks of disease amongst animals in their areas. This organisation has been found to be of very great value in preventing and controlling losses upon individual farms.

In order that investigations may be carried out upon premises at which an outbreak of disease exists, a motor laboratory has been specially built and equipped in such a way that while being capable

of considerable speed and of mobility in difficult places, it provides all the facilities for prolonged field investigations. By this means such investigations can be carried out in a thorough manner in any part of the country. A special department—under expert supervision—also exists for the preparation of vaccines and other biological substances in large amounts for experimental purposes in the field.

While several senior members of the Staff are primarily engaged in special research, they are always available to form part of a team for any particular investigation.

### **Summary of Work.**

Owing to the pressing demand for enquiry into a number of diseases of farm animals it has so far been found necessary to base the scheme of work upon the urgency of the need for these investigations, many of which are seasonal in occurrence, and not upon any definite or orderly programme. Special attention has been given to a variety of sheep diseases. Many of these occur at or about the time of lambing, which, in any one district is a relatively brief period for any investigation. It is therefore necessary to concentrate all the resources of the Institute upon these investigations during the short time which is available. It is also necessary to begin the work amongst the earliest lambing breeds in the South and to follow up the lambing time northwards until the Border Counties are reached in May. Such a procedure is only rendered possible by the motor laboratory and mobile section of the staff. As a result of this organisation it has been possible to undertake a number of investigations and to bring several to a successful conclusion in a very short space of time.

In detail, the work of the Institute is proceeding along the following lines :—

#### *Cattle.*

Tuberculin Tests.

Johne's Disease—treatment.

Contagious Abortion—Research into more appropriate and satisfactory methods of control.

#### *Sheep.*

Contagious Abortion—further experiments in prevention.

Joint Ill in Lambs—preventive vaccination and treatment.

Mastitis in ewes—etiology and prevention.

Dysentery of Lambs—etiology and prevention.

#### *Pigs.*

Swine Erysipelas—field experiments in active immunisation.

Swine fever—preventive inoculation.

Parasitic Diseases—prevention and treatment.

*General.*

Routine diagnosis of specimens and advice regarding prevention or treatment.

Field investigations of large outbreaks of disease. Preparation of experimental vaccine, &c.

*Special.*

Continuation of the chemo-therapeutic study of certain protozoa in vitro and in vivo with a view to the treatment of the diseases produced by them ; and of the cultural requirements of ultravisible organisms in general.

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(20) VETERINARY LABORATORY: MINISTRY OF AGRICULTURE AND FISHERIES.

This laboratory is situated at New Haw, Weybridge, Surrey, approximately 25 miles from London.

Nearest Railway Station (about 1½ miles) Byfleet, on the Southern Railway (about 55 minutes' journey from Waterloo Station). Telephone: Byfleet 130.

The Foot-and-Mouth Disease Station (for experiments with large animals) at Pirbright is some 7 miles from New Haw. It is reached by Southern Railway from Waterloo, and visitors should book to Woking (5 miles distant) and arrange motor transport.

#### Staff

<i>Director .. .. ..</i>	W. H. Andrews, D.Sc., M.R.C.V.S.
<i>Research Officer in charge of Poultry Disease Section</i>	T. M. Doyle, F.R.C.V.S., D.V.S.M.
<i>Research Officer in charge of Foot-and-Mouth Disease Research ..</i>	Vacant.
<i>Divisional Veterinary Inspector — Diagnosis Department .. ..</i>	W. Watt, M.R.C.V.S., D.V.S.M.
<i>Veterinary Inspector—Vaccine Department ..</i>	A. Holtum, B.V.Sc., M.R.C.V.S., D.V.H.
<i>Veterinary Inspector in charge of Pirbright Foot-and-Mouth Station ..</i>	G. O. Davies, B.V.Sc., M.R.C.V.S., D.V.H.
<i>Poultry Disease Diagnosis</i>	Lt.-Col. H. A. Reid, F.R.C.V.S., D.V.H., F.R.S.E.

#### Aims of the Laboratory.

This institution was founded for the purposes of applying laboratory methods to the diagnosis of disease, and of conducting research into problems of aetiology and prophylaxis. In connection with both routine diagnosis and research, attention is paid more particularly to diseases scheduled under the Diseases of Animals Acts, but other disease problems of economic importance are investigated as far as practicable.

#### Summary of Work.

The work undertaken at present may be summarised under two heads:

##### *Routine.*

1. Diagnosis of scheduled diseases—especially anthrax, swine fever and rabies (at present only in recently imported and quarantined dogs).

2. Diagnosis of general pathological specimens submitted by veterinary practitioners.

3. Diagnosis of disease in poultry—general post-mortem examinations of birds from field.—Bacillary White Diarrhoea—Cultural examination of chicks.—Agglutination tests on adult hens.

4. Preparation of anti-abortion vaccine. In this department diagnosis by agglutination is also carried out on a limited scale (to establish the existence of the disease in herds to be vaccinated).

5. Redwater and Anaplasmosis vaccination of cattle to be exported to tropical and semi-tropical countries (at present in abeyance, owing to restrictions on export).

#### *Research.*

1. Foot-and-Mouth Disease. Research on this disease is carried on in various institutions under the general direction of a special scientific committee. Work at the New Haw laboratory, mainly concerned with problems of disinfection and immunisation, is performed only on guinea-pigs and other small laboratory animals. All experiments on the farm animals are carried on at the special station at Pirbright, where extreme precautions have been taken in connection with the planning, erection and management of the station to secure the necessary isolation.

2. Swine Fever, and the differentiation of clinically similar porcine diseases.

3. Contagious abortion of cattle.

4. Various sheep diseases, including lamb dysentery, scrapie and "swing-back."

5. Poultry diseases, and more particularly Fowl Pox, Bacillary White Diarrhoea and Tuberculosis.

Various other diseases are encountered from time to time in the course of the routine work, or are specially brought to the notice of the laboratory, and are investigated as far as the other and more pressing duties of the staff will permit.

The New Haw laboratory has excellent facilities for performing experimental work on the larger farm animals.

(21) ANIMAL DISEASES RESEARCH ASSOCIATION  
OF SCOTLAND.

Situated at Moredun, Gilmerton, Edinburgh. Nearest Railway Station, Edinburgh. Institute three miles from Edinburgh. Motor buses pass the door. Telephone : Edinburgh 41744.

**Staff.**

<i>Director</i> .. .. ..	W. A. Pool, M.R.C.V.S.
<i>Secretary</i> .. .. ..	A. R. Milroy.
<i>Senior Research Assistant</i>	H. Preston, M.R.C.V.S., D.V.S.M.
<i>Junior Research Assistant</i>	A. Brownlee, B.Sc., M.R.C.V.S.
<i>Second Junior Research Assistant</i> .. ..	D. R. Wilson, B.Sc., M.R.C.V.S.

The Animal Diseases Research Association of Scotland was formed in 1920, when a Committee composed of representatives of the Highland and Agricultural Society, the Scottish Chamber of Agriculture and the National Farmers' Union of Scotland provided a constitution. In 1922 the Association took over the Research Staff and the work which had been carried on in the Glasgow Veterinary College with Government help since 1917. It receives two-thirds of its expenditure from the Board of Agriculture for Scotland and has to raise one-third from private sources.

On 1st June, 1926, the laboratories were moved from Glasgow into the new Institute at Moredun, Gilmerton, Edinburgh, which had been erected from funds provided by Government.

The Institute consists of four laboratories with the necessary accommodation such as sterilising and preparation rooms, stores, &c. There is good accommodation for horses and cattle and also for small laboratory animals. There are about 20 acres of grazing paddocks adjacent to the buildings. In addition to this the top floor of the Royal (Dick) Veterinary College has been fitted up specially for the Association, but this accommodation has not yet been occupied

**Summary of Work**

The Association exists for the study of the diseases of farm live stock. So far the diseases of sheep have been given first consideration because Government support was obtained for this purpose. The diseases of other farm animals have been investigated when possible. Good results have been obtained from the investigation of braxy. Lamb dysentery, louping ill and scrapie have been given detailed attention. Other diseases of sheep such as swing back, foot rot, gangrenous mammitis and certain inflammatory skin diseases are given a place in the programme.

Grass disease in horses is being investigated. It is hoped in future to give more time to cattle diseases. Work has already been done in contagious abortion and mammitis.

(22) ANIMAL DISEASES DIVISION: MINISTRY  
OF AGRICULTURE, NORTHERN IRELAND.

This Division is situated at Stormont, Strandtown, Belfast, five miles from Belfast on Dundonald tramway line.

**Staff.**

<i>Head of Division</i>	.. John P. Rice, B.Sc., M.R.C.V.S.
<i>Assistants</i>	.. George Wilson, M.R.C.V.S., D.V.S.M. Hubert G. Lamont, B.Sc., M.R.C.V.S.

**Summary of Work.**

Research work is in progress regarding sterility in cattle, anti-tuberculosis vaccination, pneumonia in pigs and diseases of poultry.

*Cattle*.—The Division has followed closely the work of Nielsen, who finds that inflammation of the womb, resulting from infection at birth or abortion, is the only important cause of sterility in cows and that the majority of cases respond to intra-uterine injections. An endeavour is being made to carry this work further by combined clinical, therapeutic, and post-mortem investigations. Bacteriological examination of diseased wombs is being carried out with a view to determining the nature of the organisms which invade the organ.

Sterility in heifers is under investigation with special reference to nodular vaginitis, which is regarded by some veterinarians as being a normal condition. The vaginal flora of normal animals is being compared with that of animals showing nodular vaginitis.

Experiments with the anti-tuberculosis vaccine of Calmette and Guerin are now in their second year. Seventy-five per cent. of calves born in a tuberculous herd are vaccinated at birth and thereafter annually, while 25 per cent. are left unvaccinated. The vaccinated and the control animals will be killed after prolonged exposure to natural infection when information will be afforded regarding the preventive value of the vaccine.

*Pigs*.—Losses are experienced amongst young pigs in Ireland from a disease or diseases known as "blows" and "thumps," which is frequently associated with pneumonia and, sometimes, with heart disease. While many of the cases show the presence of lung worms, these parasites are often absent, and the cause of the pneumonia remains obscure. A bacteriological examination of the problem is being made. Attempts to transmit the non-parasitic form of the disease or diseases to healthy pigs have, so far, been unsuccessful.

*Poultry*.—Much time has been devoted to bacillary white diarrhoea, the most important disease of poultry. Several strains of bacteriophage active against the causal bacillus of the disease have been

used for vaccination purposes. The blood or agglutination test for detecting adult carriers of the disease is being investigated with special reference to the agglutinability of the strain of *Bacillus pullorum* used as the antigen and to the dilution which indicates infection.

About two hundred wild birds have been examined by the Division for the presence of gape worms. It was found that 98 per cent. of young rooks harbour gape worms, which are morphologically identical with *Syngamus trachealis*, which cause gapes in domesticated birds. While the rook gape worm has the same structural characters as the parasite of chicks, it may be a "host" species incapable of infecting poultry. This point is being tested by feeding chicks with rook gape worms hatched in the laboratory.

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(23) INSTITUTE OF AGRICULTURAL PARASITOLOGY :  
LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE.

The Institute of Agricultural Parasitology is housed at Winches Farm, Hatfield Road, St. Albans, Herts. The nearest station for passengers is the City of St. Albans Station on the London, Midland and Scottish Railway, about  $1\frac{3}{4}$  miles distant. Expresses from St. Pancras, London, to St. Albans City, take 30 minutes. *Telephone* : St. Albans 858.

The London School of Hygiene and Tropical Medicine is the parent body and occupies at present temporary premises in the Hospital for Tropical Diseases, 23, Endsleigh Gardens, Euston Road, W.C. 1., pending the completion of new premises now in course of erection in Malet Street, to the north-west of the British Museum. *Telephone* : Museum 3326 Ext. 8.

Winches Farm occupies 33 acres, of which about three acres are woodland, 7 acres arable and 23 acres under grass.

#### Staff.

*Director* .. .. Prof. R. T. Leiper, M.D., D.Sc., F.R.S.,  
Professor of Helminthology in the  
University of London and Director of  
the Division of Medical Zoology.

*Assistant Director* .. T. W. M. Cameron, M.A., D.Sc., Ph.D.,  
M.R.C.V.S.

*Principal Research Assistant* T. Goodey, D.Sc.

*Research Assistant* .. D. O. Morgan, M.Sc.

#### Summary of Work.

The Institute specialises in the morphology, life-histories and bionomics of the internal parasites of domesticated animals, farm stock, poultry and fur animals—and of the allied eelworms which infest plants of economic importance : with special reference to those factors which have direct bearing on their control or eradication. Correlated studies are made on the host reactions induced by the migration of larval and adult forms within the hosts and of the bionomics of the intermediate hosts concerned in the spread of the chief entozoal diseases.

Efforts are being made to study not only the normal life cycles of the more important parasites but to ascertain the effect of varying conditions of climate, soil, etc., on the extent and duration of soil infectivity. Tenth-acre field plots have been established of eelworm infestation of daffodil, wheat and strawberries. Paddocks containing

infection with specific entozoal diseases such as Husk, Hookworm in Sheep, Trichinosis, "Gapes," &c., are being established. Reservoir infections of the different kinds of tapeworm of the dog which are transmitted through domesticated and food animals are in course of formation for future studies. Much of the research work in progress is theoretical and will necessarily continue to be so as this provides a fundamental basis of exact knowledge upon which the practical application to disease control must be based.

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### D.—Animal Husbandry.

#### (24) ANIMAL NUTRITION RESEARCH INSTITUTE : CAMBRIDGE UNIVERSITY.

The laboratory work of the Institute is carried on mainly at the School of Agriculture, Downing Street, Cambridge, but the Institute possesses a branch laboratory at the Field Laboratories, Milton Road. The experimental animals are kept at the Field Laboratories, at Howe Hill Farm, Huntingdon Road, and a few are actually under observation at the School of Agriculture. The nearest railway station is Cambridge, which can be reached in 1½ hours from London, either from Liverpool Street or from King's Cross. Communications should be addressed to Professor T. B. Wood, School of Agriculture, Cambridge, Telephone : Cambridge 1885 (two lines).

#### Staff.

<i>Directors .. ..</i>	Professor T. B. Wood, C.B.E., M.A., LL.D., F.I.C., F.R.S., Drapers Professor of Agriculture in the University.
<i>Consultants .. ..</i>	F. H. A. Marshall, Sc.D., F.R.S., Reader in Agricultural Physiology in the University.
<i>Consultants .. ..</i>	Sir F. G. Hopkins, M.D., LL.D., F.R.C.P., F.R.S., Professor of Biochemistry in the University.
	J. W. Capstick, O.B.E., M.A., D.Sc. Fellow of Trinity College.
	G. Udny Yule, M.A., F.R.S., University Lecturer in Statistics.
<i>Principal Assistants :—</i>	
<i>Chemist .. ..</i>	F. W. Foreman, M.A., F.I.C.
<i>Physiologists .. ..</i>	J. Hammond, M.A.
	E. T. Halnan, M.A.
<i>Senior Assistants :—</i>	
<i>Chemist .. ..</i>	H. E. Woodman, D.Sc., Ph. D.
<i>Physicist .. ..</i>	T. Deighton, Ph.D., B.Sc.
<i>Assistants :</i>	
<i>Physiologist .. ..</i>	S. A. Asdell, Ph.D.,
<i>Statistician .. ..</i>	H. G. Sanders, M.A.
<i>Agriculturist .. ..</i>	I. S. Morgan, M.A.

#### Summary of Work.

The work of the Institute is organised on two main lines : nutrition proper, under Professor T. B. Wood, and the physiology of reproduction and growth under Dr. F. H. A. Marshall.

*Nutrition proper.*—The central idea behind the work of Professor

Wood's team has been, throughout the existence of the Institute, the establishment of quantitative relations between the consumption of food and the production of live weight increase in growing and fattening animals. The broad question has been attacked from many points of view:—calorimetric observations have been made, more especially on growing pigs, to determine the maintenance requirements: comparative slaughter investigations have been carried out on pigs, sheep, cattle and fowls to determine the composition of the live-weight increase: statistical studies of the records of feeding experiments have been used with success to ascertain both the maintenance requirements and the composition of live weight increase, more especially in the case of sheep: many digestibility determinations have been carried out with pigs, sheep and poultry in order to ascertain the real nutritive value of such feeding stuffs as the various grades of millers' offals, cooked and uncooked maize, silage prepared by various methods and by standard methods from different crops, and especially freshly cut grass from different pastures.

The results of these investigations have enabled the Director to propose a method of rationing pigs, sheep and cattle on the basis of maintenance requirement adjusted according to live weight plus production requirement adjusted according to the desired rate of live weight increase. The method, with the various data necessary for its use, is set out in *Rations for Livestock*, by Professor T. B. Wood, Ministry of Agriculture's Miscellaneous Publication No. 32, 5th edition, 1927.

In addition to this main series of investigations, members of Professor Wood's section have carried on specialist detailed studies: Mr. Foreman on protein chemistry, Dr. Woodman on the process of ensilage, Mr. Halnan on poultry nutrition, Drs. Capstick and Deighton on the construction and standardization of animal calorimeters.

Finally many detailed papers on allied subjects have been published by research students.

*Reproduction and Growth.*—The broad idea of the investigations undertaken in this subject is to get a complete knowledge of all the reproductive processes of farm animals and the conditions governing the development of the young. By so doing it is hoped to obtain practical control of the factors regulating fecundity and the periodicity of breeding as well as those affecting the growth and proportions of the different organs and parts of the body. The importance of such knowledge to the farmer needs no emphasis, and its practical value has already been demonstrated. The chief practical results so far obtained have been outlined in the Research Monograph on "The Physiology of Animal Breeding, with special reference to the Problem of Fertility," recently issued by the Ministry of Agriculture and Fisheries. The details of an extended investigation on "The Physiology of Reproduction in the Cow," by Mr. J.

Hammond, have just been published. The bearing of the work on problems of milk production and practical dairying are sufficiently apparent, for it is believed that by controlling the periodicity of breeding it will be possible to regulate the milk supply throughout the year and to obtain increased yields in the winter. Similar work has been carried out by Dr. Marshall, Mr. Hammond, Dr. Asdell and other investigators at the School of Agriculture on the sheep, the goat, the pig, the dog and the smaller animals of the farm, and Mr. Hammond has begun an enquiry on the reproductive processes in the mare, an animal that shows an unusually high percentage of sterility, the causes of which stand in urgent need of investigation. At the same time Mr. Sanders is engaged in work on the statistical side of these problems. He has already published the results of enquiries into the various factors affecting milk yields in cows and the fertility of stallions.

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## (25) ROWETT RESEARCH INSTITUTE.

This Institute is situated at Bucksburn, Aberdeen. The nearest railway station is Bucksburn. Telephone : Bucksburn 8.

This Institute is devoted to Research in Animal Nutrition and was formally opened by H.M. The Queen in September, 1922. Its large modern buildings, situated within five miles of the City of Aberdeen, consist of Laboratories and Experimental Rooms for Physiology, Biochemistry, Pathology and Animal Husbandry, a well-designed set of animal houses for feeding experimental animals and a library equipped with facilities for preparing and indexing records and the compilation of statistical data. In addition to grants from Government and other sources, the late Dr. J. Q. Rowett contributed £21,000 towards the capital cost of these buildings and Mr. Walter A. Reid gifted £5,000 for the endowment of the Library and Statistical Department.

An experimental stock farm is being established at present in connection with the Institute to provide facilities for testing and applying, under practical conditions, those results of research in animal nutrition, which appear to be of economic value. In 1925 Mr. J. Duthie Webster gave a donation of £10,000 to found a trust, the income of which is directed to be used for the furtherance of the work of the experimental stock farm. Most of the land required has been purchased and some of the necessary buildings erected. The rest of the work will be proceeded with so soon as the necessary funds required for capital expenditure have been raised.

**Staff.**

<i>Director .. . . .</i>	J. B. Orr, D.S.O., M.C., M.A., M.D., D.Sc.
<i>Secretary and Treasurer</i>	E. G. Bruce, M.A., B.Sc. (Agric.).
<i>Librarian and Statistician</i>	J. S. Thomson, M.A., B.Sc., A.I.C.
<i>Biochemical Department</i>	W. Godden, B.Sc., F.I.C. (Head). Miss M. B. Richards, M.A., D.Sc. Miss B. W. Simpson, M.A., B.Sc.
<i>Physiology Department ..</i>	H. E. Magee, M.B., Ch.B., D.Sc. (Head). J. M. Henderson, M.A., M.B., Ch.B., D.Sc. Miss I. Leitch, M.A., D.Sc.
<i>Pathology Department ..</i>	J. P. McGowan, M.A., B.Sc., M.D. (Head).
<i>Animal Husbandry Department</i>	A. Crichton, M.A., B.Sc. (Agri.), (Head). J. A. Crichton, M.A., B.Sc. (Agri.). W. Middleton, N.D.A., U.D.A. Miss M. Moir, N.D.A., U.D.D.

**Summary of Work.**

The main work of this Institute consists on the one hand of investigations into the energy and material requirements of farm animals

under conditions of maintenance and various kinds of production and the best means of meeting these requirements ; and on the other hand of investigations into the constituents of and the digestibility and nutritive value of various feeding stuffs. The main trend of the present research policy of the Institute is the investigation of problems connected with the mineral metabolism of farm animals. In this connection work has been carried out, among other things, on :

- (1) The mineral content of pastures.
- (2) The effect of ultra-violet irradiation on metabolism.
- (3) Iodine.
- (4) The mineral content of feeding stuffs.

*The Mineral Content of Pastures.*—A large number of analyses of pastures from different areas at home and abroad has been carried out at the Institute, and the data shows that there are marked differences in the mineral content of good and poor pastures, particularly with regard to calcium, chlorine and sodium. Seasonal variations in the mineral content of any given pasture were also observed, and clinical observations on the areas of collection indicated some correlation between the occurrence of disease and low mineral content of pastures. Practical feeding experiments with sheep are in progress to determine whether the supplementing of poor pastures by the addition of minerals in the food will result in an improvement in the rate of growth and the health of the sheep grazing thereon. An extension to Colonial areas of the field covered by this investigation on the mineral content of pastures has been financed through the Empire Marketing Board, and investigations are running in Kenya Colony and other parts of the Empire.

*Effect of Ultra-violet Irradiation.*—It has been found that ultra-violet rays, artificially produced, increase the absorption and retention of calcium and phosphorus in young pigs, the increase being evidently due to increasing the absorption from the intestinal tract. This result has been confirmed at other institutions.

Depletion of calcium is regarded as a probable cause of malnutrition in heavy yielding milk cows, and if irradiation could help to prevent this depletion, it might prove to be a factor of economic importance in milk production. When the new buildings of the Experimental Farm are erected, tests to determine the practical value of ultra-violet irradiation in cows will be carried out. So far, in experiments with goats, it has been found that irradiation does actually decrease the loss of calcium from the body.

*Iodine.*—A method of analysis, which is a modification of a method recently introduced in Germany, has been worked out at this Institute and is sufficiently delicate to determine with accuracy the very small amounts of iodine contained in feeding stuffs and in body fluids. Using this method, the following results have been obtained. (a) There are considerable differences in the iodine

content of pastures, soils and water in different areas in this country ; some pastures are five or six times as rich in iodine as others. (b) The iodine content of milk appears to be variable ; some samples examined contained only about one quarter of the concentration of iodine present in other samples. (c) The amount of iodine contained in milk is dependent upon the iodine content of the food ; it can be increased by adding iodine to the diet of the lactating animal. (d) The iodine content of colostrum is very high compared with milk secreted later.

In addition, a large number of feeding trials, based on the results of laboratory experiments, have been conducted with a view to determining the optimum dose of iodine for growth.

*The Mineral Content of Feeding Stuffs.*—The object of this investigation is to obtain reliable information as to the mineral content of feeding stuffs most commonly used in agricultural practice in this country. Many of the feeding stuffs made from tropical products and commercial by-products are known to be markedly deficient in certain mineral constituents and as these are commonly used in intensive feeding in this country, the results of this investigation, when published, will provide farmers and others with a working basis for compounding rations.

In addition to the above, a large number of feeding experiments with poultry have been carried out in conjunction with the three Colleges of Agriculture in Scotland and the Department of Agriculture of Northern Ireland.

A considerable amount of work, but so far of academic interest only, has been carried out in connection with the feeding of different concentrations of minerals in the food on the peristalsis of the intestine and with the etiology of the various forms of anæmia.

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(26) [CHEMICAL AND] ANIMAL NUTRITION DIVISION:  
MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

For particulars of situation, staff and soil work see p. 23.

### Summary of Work.

*Beef Production.*—Work has been in progress since 1922 on the production of baby beef, that is fat cattle suitable for the butcher, weighing from 7 to 10 cwt. at 14 to 18 months old. Experimental results have been published demonstrating that the production of "baby beef" is a more profitable venture than the prevailing practice of rearing store cattle for export to Great Britain at ages varying from 18 months to 3 years. This work has been undertaken because it is felt that the future of the beef trade lies with medium weight cattle and that there will probably be a steadily decreasing market for  $2\frac{1}{2}$  to 3 year old heavy weight cattle.

*Milk Production.*—As soon as the organization of the central experimental farm at Hillsborough has been completed it is proposed to explore the problem of maintaining a heavy-milking tuberculosis-free herd and of prolonging the milking life of the dairy cow. It is felt that this problem is closely related to the nutrition, and in particular to the mineral nutrition, of the cow. Preliminary arrangements for this work have already been made.

*Pigs.*—Two problems are being investigated ; (1) the cause of the difficulties experienced in maintaining a large breeding herd of pigs and of rearing and fattening their litters when no milk or only a relatively small quantity of milk is available. A preliminary report of this work has been published. (2) The influence of feeding on the type and quality of the bacon.

*Sheep.*—In collaboration with the Rowett Research Institute an inquiry is in progress as to effect of feeding on birth rate, mortality and growth of the lambs, and of feeding a mineral mixture to mountain breeding ewes during the period October to April.

*Poultry.*—Experimental work is being carried out on the following, amongst other problems :—

- (1) The protein and mineral requirements of heavy laying pullets.
- (2) The effects of feeding on the number and size of the eggs.
- (3) Vegetable *versus* animal foods as a source of protein for laying birds.
- (4) The mineral requirements of growing chicks.
- (5) The effect of a high and low level of nutrition on the rate of maturity of the young pullet and on the subsequent egg production.

This work is being conducted in collaboration with the Rowett Research Institute and the Poultry Departments of the Scottish Agricultural Colleges. Preliminary results have been published.

*Silage.*—An investigation on the feeding value of silage for dairy cows has been completed and the results published.

(27) [CROP AND] ANIMAL HUSBANDRY RESEARCH  
DIVISION: MINISTRY OF AGRICULTURE, NORTHERN  
IRELAND.

The Division is situated at the Queen's University, Belfast.

**Staff.**

*Head of Division.. . . R. Rae, B.Agr.*

This Division commenced operations in January, 1926, and since then its work has been mainly devoted to advisory duties in connection with the production of Grade A (T.T.) milk. The principal research work of the Division will be carried out at the farm of the Agricultural Research Institute of Northern Ireland situated at Hillsborough, County Down, to which reference is made on page 80.

(28) POULTRY DIVISION: MINISTRY OF AGRICULTURE,  
NORTHERN IRELAND.

This Division is situated at Stormont, Strandtown, Belfast, 5 miles from Belfast on Dundonald tramway line.

**Staff.**

<i>Head of Division..</i>	..	Miss M. J. Sheedy.
<i>Assistants</i>	..	Miss H. C. Walker. Miss M. E. Osborne.

The research work of the Division is carried out in close collaboration with the Chemical and Animal Nutrition Division and particulars of the work in progress are given under the notes for that Division (see page 77). The official Egg Laying Tests for Northern Ireland are conducted at the Poultry Division.

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(29) AGRICULTURAL RESEARCH INSTITUTE: MINISTRY  
OF AGRICULTURE, NORTHERN IRELAND.

The Agricultural Research Institute situated at Hillsborough in County Down (about twelve miles from Belfast and about one mile from Hillsborough Railway Station) consists of an experimental farm of almost 500 acres. As explained in the section dealing with the organization and administration of agricultural research and experimental work in Northern Ireland the station is controlled by a Board of Trustees who will have an endowment fund producing an income of approximately £3,000 per annum. Possession of this farm was obtained by the Trustees on 1st April, 1927, and the station is in process of being equipped mainly for the development of work on animal nutrition.

*Joint Directors* { Management .. Robert Rae, B.Agr.  
                    Research and Experiments .. G. S. Robertson, D.Sc., F.I.C.

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(30) THE NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

Shinfield Manor House, the Headquarters of the Institute, is about four miles from Reading Stations G.W.R., and S.R., and within half an hour's walk of the Reading Corporation motor 'buses which pass the Reading Railway Stations on their way to and from Shinfield. *Telephone*: Spencers Wood 3.

In the Manor House are the Dairy Chemistry and Dairy Bacteriology Laboratories, the Library, the offices of the Dairy Husbandry Department and the Administrative offices.

Church Farm, the experimental farm of the Institute, is close to the Manor House, and the fact that old and modern buildings exist side by side is a feature which is of considerable interest to visitors. The buildings comprise stabling and barns, an old cowshed which was in use when the Institute first obtained its licence to produce "Grade A Tuberculin Tested Milk" and newly-erected buildings consisting of cowsheds, bull pens, calf pens and feeding stores, milking shed and dairy.

### Staff.

*Director* .. . . . R. Stenhouse Williams, M.B., C.M., D.Sc., D.P.H., L.R.C.P. and S.E.

*Bacteriological Department* :—

Professor R. Stenhouse Williams (*Head*)  
A. T. R. Mattick, B.Sc. (Agric.)  
Edith R. Hiscox, M.Sc. (London), B.Sc. (Bristol).

*Chemical Department* :—

Capt. J. Golding, D.S.O., Chevalier de Merite Agricole, F.I.C. (*Head*)  
Mrs. Mattick, M.Sc., Ph.D.

*Dairy Husbandry Department* :—

J. Mackintosh, O.B.E. (*Head*)  
S. Bartlett, M.C., N.D.D.

### Aims of the Institute.

Within the province of the Institute are included all questions relating to the production, handling and distribution of milk, and the manufacture of dairy products. These involve the study of the management and feeding of dairy herds, of methods of securing and distributing milk, of the constitution of milk and milk products, of the various activities in the dairy, and the technical processes involved in the making of such products as butter and cheese.

### Summary of Work.

#### *Experimental Work on the Farm.*

In order that the value and effect of foodstuffs fed to cattle may be understood, studies are being made of the botanical and chemical constitution of various foods, and the effect thereon of different methods of cultivation and manuring. The field experiments deal with (a) the yield, dry matter content, and keeping qualities of varieties of mangels ; (b) the effect of surface cultivation on limiting the growth of weeds in lucerne during the first and second seasons' growth ; (c) the nitrogenous manuring and heavy stocking of pasture land grazed by cows ; and (d) the suitability of different mixtures of cereals and pulse crops for silage.

Experiments are being conducted on the feeding of stock, including investigations (a) on the rations required to rear yearling heifers ; (b) on the effect of certain winter rations on the vitamin content of milk ; (c) on the effect of additional oils, e.g., cod-liver oil, on the percentage of fat in cows' milk.

Experiments are also being carried out on the frequency of sampling and testing necessary to ascertain the average percentage of fat in the milk of a lactation period, and on the relative absorptive capacity for water of different cattle foods.

The question of the handling of milk, in the cowshed and from thence to the retailer, is also being studied. This involves the study of methods of milking—hand milking and machine milking ; the effect upon the cleanliness of the milk of steaming dairy utensils ; and the influence of methods of carriage and transport. In this connection members of the staff have conducted investigations both at the farms where the milk is produced, and at the retailer's premises in Reading, London, and elsewhere, to which it is delivered, so that a complete picture may be obtained.

Certain specific taints found in milk, e.g., "oilness" are also under investigation.

In connection with milk products, a number of experiments are being carried out on the use of different types of "starter" in the making of butter, the necessity or otherwise of using some form of preservative in butter and the influence of these agents on the flavour of butter.

Studies are also being made of the possibility of preserving over long periods of time pure cultures of "starter" for use in the preparation of cheese. Up to date, it has been found possible to preserve such cultures for at least a year, and with improved methods it is conceivable that this period may be extended.

In the past, cheese has been liable to faults which have had their origin in the methods of handling the milk in the cowshed and at intermediate stages. The whole problem of cheese-making is therefore being studied from the beginning, and it may be a long time before any conclusions can be reached, owing to the great variety of physical, chemical, and biological changes which occur in the process of cheese ripening.

Certain specific faults, e.g., "Red Spot" and "Black Spot," are under investigation.

The disposal of dairy by-products is also receiving consideration. In this country there has been considerable financial loss owing to the wastage of whey, and in an endeavour to overcome this difficulty two series of experiments have been carried out :—

- (1) On behalf of the Ministry of Agriculture, by which a method has been devised at Haslington, near Crewe, for evaporating whey and preparing sugar therefrom; and also preparing what has proved to be quite an excellent food-stuff, at any rate for animals. The method involves the provision of a considerable amount of machinery, and it is estimated that to make it an economic success, about a million gallons of whey a year are required.
- (2) A method has, therefore, been devised at the Institute which it is hoped will prove of value in small dairies. By this method the whey is pre-heated and run over roller dryers, and the product obtained has proved to be a valuable foodstuff for animals. The method adopted is that of utilising, by means of a special device, the waste heat from the rollers for preheating the whey before it reaches the roller, thus effecting a great economy in the use of steam. This method is now being tried out in one or two creameries, and it is hoped that it will prove a useful aid in the solution of the whey problem.

The feeding values of milk and its products are also being investigated. The vitamin value of butter made from the milk of experimentally fed cows is being studied by the carrying out of extensive rat feeding experiments. Experiments are also being conducted on the value of whey, dried whey and other dairy by-products as an addition to the diet of pigs. Further experiments will be made, designed to differentiate the relative nutritional value of the components of milk as judged by pig feeding. The effect of heat on the value of milk, as shown by feeding to rats, is also being studied.

Work is also being done at the Institute on the testing of dairy machinery and appliances. These play their part at all stages in the production, handling and distribution of milk and its products, and it is important that they shall be efficient for the purposes for which they are designed. Tests of efficiency are, therefore, made for the benefit of the makers, and as time goes on, this work should tend to prevent the sale of machinery and utensils which, while mechanically efficient are not necessarily satisfactory from the point of view of the industry. Among the articles tested have been milking machines, separators, a bottle washing machine, milk coolers, churns, covered milking pails and milking stools.

In conclusion, it may be stated the value of the work of the Institute is not limited to this country, and the study of some of the problems now under investigation was undertaken at the request of representatives of the Dominions.

(31) SMALL ANIMAL BREEDING RESEARCH INSTITUTE:  
CAMBRIDGE UNIVERSITY.

Laboratory work of this institute is carried out at the School of Agriculture, Downing Street, Cambridge, and field work at the University Experimental Farm, Huntington Road, Cambridge.

**Staff.**

<i>Director</i> .. ..	Prof. R. C. Punnett, M.A., F.R.S.
<i>Assistant</i> .. ..	M. S. Pease, M.A.

**Summary of Work.**

The following investigations are in hand :—

(a) *Rabbits* :—

- (1) Inheritance of weight in rabbits. This set of experiments is drawing to a conclusion and it is hoped to put together the results for publication in the course of the present year.
- (2) Inheritance of yellow fat. The genetical nature of this is now clear, but publication is being held up until the reason for its non-appearance in the albino series is determined, and until certain chemical investigations have been finished.
- (3) Experiments on the linkage of Angora wool with certain coat patterns.
- (4) Experiments on the genetical nature of precocity in sexual maturity and on litter size.

Series (3) and (4) have been recently started and will expand as hutch room becomes available through the gradual conclusion of (1) and (2).

(b) *Poultry* :—

- (1) Experiments on the extent of white in the down of certain black breeds.

In certain strains of Black Leghorns and in Sumatra Game the white neutral area of the down invades the head, and when such blacks are used for crossing with cuckoos to give a sex-linked result the white head patch of the cuckoo chicks is often obscured, thereby making it difficult to tell the sexes apart at hatching. The work has shewn that this is due, in part at any rate, to the strains in question carrying a factor for pied plumage (which is

associated with a large amount of white in down), and has further shewn how the disturbing factor may be eliminated. An account of these experiments will be published shortly.

- (2) Experiments for testing whether there exist sex-linked factors affecting fecundity in the hen. These are making progress, but it must be some years before a definite result can be obtained.
  - (3) Inheritance of certain comb characters.
  - (4) Experiments to test whether the strength of linkage depends on the age of the bird.
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(32) ANIMAL BREEDING RESEARCH DEPARTMENT :  
EDINBURGH UNIVERSITY.

This Department is stationed in King's Buildings, West Mains Road, 1½ miles from G.P.O. Telephone: Edinburgh 42567.

At present the Department is accommodated in the buildings of the Chemistry Department, having been allotted six laboratories; about 30 acres of land are at present available on the King's Buildings site. The generosity of the International Education Board and of Lord Woolavington has made it possible to proceed almost at once with the erection of buildings for the Department. The Department that is to be will be thoroughly equipped for the work. It is hoped to get a farm outside Edinburgh for large scale breeding experimentation. For this and allied purposes an appeal for funds has recently been made to the public.

**Staff.**

<i>Director</i> .. .. ..	F. A. E. Crew, M.D., D.Sc., Ph.D.
<i>Animal Geneticist</i> (sheep)	J. A. Fraser Roberts, M.A.
<i>Sex-physiologist and Cytologist</i> (fowl) ..	A. W. Greenwood, M.Sc., Ph.D.
<i>Animal Geneticist</i> (pig, goat, horse, cattle) ..	A. D. Buchanan Smith, M.A., M.Sc.
<i>Animal Geneticist and Statistician</i> (sheep) ..	J. E. Nichols, M.Sc.

**Aims of the Department.**

The function of the Department is to secure and to publish knowledge concerning the physiology of reproduction and of inheritance with special reference to the animals of economic importance.

The methods used are :—

- (1) The genetical analysis of breeds and of present-day breeding methods.
- (2) The experimental application of principles and practices which have resulted from the study of laboratory animals to the case of the animals of the farm.
- (3) The search for new knowledge by means of planned experimentation with convenient material.

**Summary of Work.**

The following are examples of problems now being investigated :—

- (1) The genetical aspects of sterility in domestic animals.
- (2) The mode of inheritance of defects (e.g., hernia, hermaphroditism) and of disease resistance in domestic animals.

- (3) The mode of inheritance of milk quantity and quality in the goat.
- (4) The physiology of reproduction and of growth in the pig.  
The analysis of the hereditary constitution of the pig.  
The exact definition of the "Ideal Pig," and the methods of breeding such. Advanced Registry. The Ton litter.
- (5) The biology of the fleece of the sheep. The structure of the component fibres of the fleece. The effect of environmental influences on fleece characters. The inheritance of fleece characters. The development of the fleece. The relation of birth fleece to adult fleece.
- (6) The genetical analysis of the making of the breeds of cattle and horses, e.g., the role of inbreeding in the making of the Clydesdale and the Aberdeen-Angus.
- (7) The sex-physiology of the fowl. The significance of sex-reversal and of intersexuality. Fecundity and fertility.
- (8) The mechanism of sex determination in domestic animals. The sex-ratio and the question of its control.
- (9) The wool of the Angora rabbit. Its structure and development. The effect of environmental agencies thereupon.
- (10) Fundamental studies of the physiology of reproduction and inheritance in the fruit-fly, *Drosophila melanogaster*, the mouse, the rat, the guinea-pig, and the rabbit.

It is intended that the Department shall become the training ground for such overseas men as wish to specialise in the scientific investigation of the breeding problems of live stock.

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### E.—Agricultural Economics.

#### (33) AGRICULTURAL ECONOMICS RESEARCH INSTITUTE : OXFORD UNIVERSITY.

This Institute is situated in Parks Road, Oxford. Nearest railway station, Oxford. *Telephone:* Oxford 2775.

#### Staff.

<i>Director .. ..</i>	C. S. Orwin, M.A.
<i>Advisory Economist ..</i>	A. Bridges, M.A.
<i>University Lecturer in</i>	
<i>Agriculture .. ..</i>	W. R. Peel, M.A., D.S.O.
	R. N. Dixey, B.A.
	F. J. Prewett, B.A.
	S. J. Upfold, M.C.
	G. Frecheville, B.A., M.A.
	E. Thomas, B.Litt., B.Sc.

#### Aims of the Institute.

The study of the structure of the agricultural industry and of the organisation of the farm is a comparatively recent development of modern agricultural research. In its earlier stages the investigation of the farmer's problems had been limited to the application of the physical and biological sciences to the production of crops and the breeding and feeding of live stock, and the setting up of the Institute in 1913 marks the realisation of the fact that the application of economics can also serve the rural community in many important ways. Not only is this necessary in the interests of the farmer and his man, but investigation is needed also of the larger question of the place of agriculture in national economy, and of the problem of the directions in which development is possible in a country so highly industrialized as Great Britain.

#### Summary of Work.

The work of the Institute falls under three principal heads :—

##### I. *Farm Management Studies.*

In the great majority of cases this class of work involves personal investigation amongst farmers and others engaged in the agricultural industry whose co-operation is vital to the conduct of such studies. Briefly the methods may be classified thus :

1. Cost accounting.                    { embracing the whole of the
  2. Financial accounting.            { operations of the Farm.
  3. Surveys,
- (1) directed to investigation of the whole business of the farm; or

(2) dealing only with individual items of farm production or the cost of operating equipment, &c.

1. *Costing*.—At the present time twenty-two farms, ranging in size from 150 to 2,403 acres, covering a total area of 10,424 acres, are being fully costed. Much information of general value is being obtained from the cost data. For example, in operating expenses, it is found that horse labour varies from 3·4d. to 9·4d. per horse-hour. The lower costs are usually found when a high number of hours are worked per annum, but this is not universal, for quite low costs are sometimes found on grass farms where very little winter work is done and the horses are kept out of doors. This rather suggests that there is an *optimum* number of days of work and costs for different styles of farming.

In addition to full cost accounting a study by survey methods of the costs of growing sugar beet in the Advisory Province of Oxfordshire and Northamptonshire is going on, and reports are issued from time to time.

2. *Financial Accounts*.—The collection and examination of financial accounts from various farmers was first undertaken in 1925, and is being continued.

3. *The Survey*.—(a) GENERAL SURVEYS. The following general surveys have been carried out by the Institute :

District.	Type of Farming.	No. of Farms.
1. Upper Thames Valley in Berkshire and Oxfordshire .. ..	Mixed .. ..	90
2. Oxfordshire (North) .. ..	Arable .. ..	172
3. Northamptonshire .. ..	(Feeding and Dairying)	
4. Oxfordshire (South) .. ..	Mixed .. ..	145
5. " " .. ..	Mixed .. ..	119
6. Wiltshire .. ..	Dairying .. ..	200
7. Northamptonshire .. ..	Dairying .. ..	70 (Approximate).
8. Northamptonshire and Leicestershire .. ..	Feeding .. ..	80 (Approximate).
Total .. ..		876

It is not possible here to elaborate the information which has been collected from these surveys. The details are made available as the various reports are published.

b. SPECIAL SURVEYS.—(a) *Small Holdings*.—A study of the social and economic significance of the small unit of cultivation in a typical peasant district has just been completed and published.

(b) *Market Gardening in the Vale of Evesham*.—A special study is in progress of the origin, growth, and present development of the fruit growing and market gardening industry in the Vale of Evesham. In order to obtain accurate information a detailed study of the holdings in one typical parish was undertaken. Data have been collected as to the different crops grown and rotations practised, yields of crops, kinds and quantities of manures used, methods of marketing produce, number of men employed, rent, rates, &c., conditions of tenure, with special reference to the Evesham Custom, and any other facts likely to throw light upon the economic development of this industry. The survey is not yet complete.

(c) *Grade A (Tuberculin Tested) Milk*.—With invaluable assistance given by Reading University, the Institute has carried out an investigation of the economics of Grade A (T.T.) milk, and a report has been published by the Institute.

(d) *Sugar Beet*.—The Subsidy voted in Parliament in 1924 on sugar manufactured in Great Britain from home-grown beet, gave the necessary impetus to the growing of sugar beet in this country, and in view of the insistent demands made by farmers to be informed of the prospects of sugar beet, it became necessary to make a careful and unbiased survey of the economics of the crop in its broadest aspects. In order to answer the questions of more immediate importance a cost of production study was inaugurated by the Institute in the autumn of 1924 to cover the operation of the 1924–5 crop, which was the first to receive the benefits of the subsidy, and the results of the study are embraced in the Research Monograph No. 3, published by the Ministry of Agriculture and Fisheries at the end of 1925. The work is being continued and extended.

4. *The Maintenance of Arable Farming*.—A recent research undertaken by the Institute is directed towards the consideration of how to maintain the proportion of plough-land. Statistics show that the war-time accretions have been lost and the arable total is now below its previous low record. Everybody knows that plough-land employs more labour and yields a greater product than grass-land (except in some of the more favoured dairying districts) but it has still to be demonstrated that certain types of land can yield a profit under the plough in the prevailing economic conditions, and that farmers are not justified in playing for safety by laying land down to grass. Recent experimental work in the direction of live stock maintenance on arable crops instead of on grass, combined with the experience of farmers here and there who have had the courage to experiment for themselves, gives reason to hope that a departure from the traditional practice in the direction of using plough-land more for the

growth of forage crops for stock, and less for corn crops, will show financial results which will justify the extension of the present arable area.

5. *The Operation of the Law of Diminishing Returns in Agriculture.* Somewhat closely associated, in principle, with the foregoing investigation is another which is being undertaken to show in what precise way the "law" operates as regards agriculture, what quantitative interpretation can be given to it and, this done, what conclusions may then be drawn.

6. *The Marketing of Farm Products.*—Research in marketing problems was first undertaken in the beginning of 1925. It was felt that from the farmer's point of view it was clearly no less important to understand how to dispose satisfactorily of commodities than how to produce them in the first place.

Most farmers, investigators, and other persons interested entertain general ideas to the effect that there are too many middlemen, that the spread between producer and consumer is too great, and that farm produce lacks the consistency and standardisation which is essential to economic distribution, and they agree on certain general remedies for these problems, chiefly by popularising the theory of co-operation. But there appeared to be a serious absence of precise information concerning the actual processes of agricultural marketing, without which it would obviously be unwise to endeavour to provide remedies. This pointed to the necessity for a detailed study of the subject from the farmer's point of view.

Two reports have been published so far, dealing with the Marketing of Meat and of Milk respectively.

7. *The Insurance of Farm Live Stock.*—In the Report of the *Agricultural Tribunal of Investigation* the need for statistical data concerning the incidence of live stock mortality in this country was emphasised. Such information is of primary importance if anything is to be attempted in the direction of the extension of live stock insurance, and practically nothing is available at present. On the other hand, much work has been done in Continental countries to investigate the facts, and the information collected has been utilised largely for the formulation of insurance schemes.

In pursuance of the suggestion made by the *Tribunal*, work was begun on the collection of data in 1924, and at the same time a study of Continental data, of which a great deal exists, was undertaken. Considerable progress has been made.

## II. *Rural Life Studies.*

*The Survey of Rural Industries.*—From time to time the scope of the work of the Institute is extended to the consideration of problems outside the organisation of farming, as when a comprehensive survey of the rural industries of England and Wales was

undertaken. The survey was recently completed, and for convenience of publication the reports have been collected together, in four volumes, as follows :

*England.*

Vol. I.—Timber and Underwood Industries and Some Village Workshops.

Vol. II.—Oyster-growing, Basketry Industries and Some Rural Factories.

Vol. III.—Decorative Crafts and Rural Potteries.

*Wales.*

Vol. IV.—Rural Industries in Wales.

Vols. I, II and III have already appeared and Vol. IV will be ready in the autumn.

*III. Miscellaneous Studies.*

Miscellaneous studies are undertaken from time to time, largely by research scholars attached to the Institute. Those completed include an Agricultural Atlas of England and Wales, published by the Ordnance Survey Department.

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### F.—Agricultural Engineering.

INSTITUTE OF AGRICULTURAL ENGINEERING:  
OXFORD UNIVERSITY.

Address : 37A, St. Giles, Oxford. Railway Station : Oxford ;  
Telegrams : Machinery Oxford ; Telephone : Oxford 3166.

#### Staff.

<i>Director</i> .. .. ..	Brynar James Owen, M.A., M.Eng., D.Sc.
<i>Mechanical Engineering</i>	E. B. Black, B.Sc.
<i>Agricultural Physics</i> ..	J. H. Blackaby, B.Sc.
<i>Electrical Engineering</i> ..	C. A. C. Brown, B.Sc., A.M.I.E.E.
<i>Agricultural Physics and Chemistry.</i>	W. H. Cashmore, B.A., N.D.A.

#### Aims of the Institute.

This, the youngest Agricultural Research Institute in Great Britain, was established in April, 1924, by the Ministry of Agriculture and Fisheries to continue and extend the work in agricultural engineering conducted previously by the Machinery Section of the Ministry.

Its object is to undertake research into all departments of agricultural engineering. Though the teaching side of its work has not as yet been much developed, the provision of instruction in agricultural engineering is also part of its programme. It is also called upon to assist in the testing of agricultural machinery under the Ministry of Agriculture's testing scheme, inaugurated in 1926. Apart from these official tests, it conducts trials and demonstrations. It is also prepared to answer enquiries relating to agricultural engineering of which a large number is received not only from Great Britain but from other parts of the Empire.

#### Summary of Work.

The main subjects of research hitherto studied at the Institute have been (*a*) The artificial drying of crops in the stack, (*b*) the generation of electricity by wind-power, (*c*) the value of sub-soiling and (*d*) the extraction of sugar from sugar-beet by the desiccation process. To these have lately been added (*e*) the use of electricity on the farm and (*f*) field drainage. Of these the first three were originally undertaken by the Ministry of Agriculture. Other investigations are projected.

(*a*) *The Artificial Drying of Crops in the Stack.*—The difficulty of harvesting hay and cereals in wet weather has led from time to time to the adoption of various devices. The idea of supplying air artificially by means of a fan seems to date from 1866. In later years the availability of cheaper sources of power has led to the

reopening of the question. In the trials of the Ministry of Agriculture in 1923, the apparatus was confined to a power-driven fan, by which air at atmospheric temperature was forced into a central chamber round which the stack had been built. This process proved too slow and unreliable.

The next series (1924) of experiments, conducted by the Institute, was accordingly directed to find an efficient method of heating the ingoing air. The method adopted consists in drawing the air through a closed tank, with flues heated by oil burners, in such a way that the air is frequently brought into contact with the heat radiated from the flues. It then passes under pressure from the fan into the central chamber. The heat was originally obtained from high pressure paraffin burners, but better and cheaper results have recently been obtained from a low pressure system using fuel oil.

(b) *The Generation of Electricity by Wind-Power.*—Investigations were in 1925, carried out by the Institute on seven different mills representing the multi-bladed, streamline and semi-stream-line types. The object of the investigation was mainly economic and the output of each mill, calculated over a whole year, was set against the total annual charges. The cost per unit of electricity varied from 4d. to 12·7d. Rather more than half of the cost is due to the necessity of having a battery for storage to tide over periods of calm and also to steady the power supply, which would otherwise rise and fall with the wind. To eliminate the battery altogether would be impossible but by exercising care, or by having a subsidiary source of power in reserve, the size of the battery might be reduced. It is not suggested that wind-mill generated electricity should be preferred to public supply where such is available, but it should be of distinct use in remote districts, especially those of high altitude or near the coast, where more continuous wind can be relied on.

(c) *Sub-soiling.*—The process of sub-soiling aims at breaking up and loosening the soil below the depth ordinarily reached by ploughing, without bringing that soil to the surface. It must consequently be carefully distinguished from deep ploughing, which brings the lower soil to the surface, where it may require a considerable amount of weathering before it becomes fertile. A trial of sub-soiling implements was held in October, 1922, in Kent and in the winter and spring of 1922–23 plots on various types of soil were laid down in Essex. All these plots were ploughed to a uniform depth of 5 inches, and of these certain were sub-soiled to further depths of 5, 7 and 9 inches, the extra cost of sub-soiling varying according to soil and depth up to 13s. 11d. per acre. In subsequent years the plots were again ploughed but not again sub-soiled. The results obtained over three years have been strikingly in favour of sub-soiling, especially with potatoes and roots. The extra yields obtained on the sub-soiled plots have not only paid the cost of the one sub-soiling but have left a wide margin of profit; the fact that in the

third year after sub-soiling the increase of yield on the sub-soiled plots was still considerable is evidence of the permanency of the effect of the one operation.

(d) *Sugar Beet*.—During 1924 the attention of the Ministry of Agriculture was directed to an Italian process for the extraction of sugar from sugar beet, known as the de Vecchis process. The main feature of the process was the drying, in two stages, of the beet in small slices. The second stage of drying was said to have the effect of rupturing the cell walls and of coagulating the albuminoids, thus facilitating extraction and simplifying the subsequent process of purification. A Commission, appointed to visit Italy and examine the process, in the course of a report issued in February, 1925, recommended the installation of an experimental plant and the undertaking of experiments with the view of devising a complete equipment, of capacity suitable for operation by the beet grower, for cleaning, slicing and drying. The dried beet would cost considerably less to transport to the central extraction factory and, as it would keep indefinitely, the extraction process could be carried on over a whole year instead of being confined to less than a third of the year, thus considerably reducing the cost of factory erection and regularising labour requirements.

A grant made by the Ministry of Agriculture permitted research on a laboratory scale to be begun in 1925. Early in 1926 an experimental factory was opened at Eynsham, near Oxford. Using a conveyor drier on the lines of that used in Italy, it was found that the second stage of drying could be dispensed with (particularly as one of the effects claimed for it, of rupturing the cell walls, was not produced) and the time of drying considerably shortened. Three forms of drier were devised, to which the methods already used by the Institute in the process of drying crops in the stack could be applied—a conveyor drier, a cylindrical cage drier and a tray drier. While these may be used on a factory scale the two latter are specially suited to the requirements of the grower. On the tray drier, during the early months of 1927, 600 tons of beet were successfully dried. Extraction and the subsequent processes of purification and crystallisation have also been carefully studied and methods have been adapted to deal with a raw juice of a density more than three times as high as that obtained in the ordinary process.

(e) *Electricity on the Farm*.—An investigation has been begun into some eight electrified farms in the Chester area. The object is to gain reliable data as to the nature of the farming load (its amount, variation and frequency), the power consumption of the various machines, and the best arrangement of equipment and distribution of machines for group or unit drive. The question of costs is also being carefully studied.

(f) *Field Drainage*.—Advantage has been taken of demonstrations in mole-draining, organised by the Ministry of Agriculture, to obtain

data as to the working of various types of mole-ploughs. In view of the growing popularity of this type of drainage and the tendency to use tractor-drawn machines, cutting shallower drains, studies are being made as to the effectiveness of these drains, their permanence and resistance to overhead pressure.

(g) *Other projects.*—Investigations projected include the generation of electricity for farm use from small water supplies, the use of electricity for cultural operations, comparative trials in tillage machinery, including rotary tillage, grain drying and the applicability of the combined harvester-thrasher to English conditions.

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**ADVISORY CENTRES AND SPECIALIST ADVISORY  
OFFICERS.**

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**Great Britain.**

Advisory Areas.	Advisory Centre.	Specialist Advisory Officers.
<b>1. Northern Province.</b> Cumberland Westmorland Durham Northumberland	Armstrong College, Newcastle-on-Tyne	Chemistry—B. Thomas; M.Sc. Dairy Bacteriology—D. W. Henderson. Economics—D. H. Dinsdale, M.A. Entomology—R. A. Harper Gray, M.A., M.Sc. Mycology—F. T. Bennett, B.Sc. Veterinary Science—G. Howie, F.R.C.V.S.
<b>2. Yorkshire.</b> Yorkshire, E. Riding Yorkshire, N. Riding Yorkshire, W. Riding	Department of Agriculture, The University, Leeds	Chemistry—H. T. Jones, B.Sc. Economics—Dr. A. G. Ruston. Entomology—T. H. Taylor, M.A. Mycology—W. A. Millard, B.Sc.
<b>3. Midland Province.</b> Derby Leicester Lincoln(Lindsey) Nottingham Rutland	Midland Agricultural and Dairy College, Sutton Bonington, Loughborough	Chemistry—H. T. Cranfield.. Economics—A. Jones, B.Sc. Entomology—A. E. Roebuck. Mycology—H. H. Stirrup, M.Sc.
<b>4. Eastern Province.</b> Bedford Cambridge Essex Hertford Huntingdon Isle of Ely Lincoln(Holland) Lincoln (Kesteven) Norfolk Soke of Peterborough Suffolk, East Suffolk, West	School of Agriculture, Cambridge University	Chemistry — L. F. Newman, M.A., F.I.C. Dairy Bacteriology—G. Morgan, N.D.A., N.D.D. Economics—J. A. Venn, M.A. Entomology—F. R. Petherbridge, M.A. Mycology—W. A. R. Dillon Weston, M.A.

Advisory Areas.	Advisory Centre.	Specialist Advisory Officers.
<b>5. South Midland Province.</b> Northampton Oxford	School of Rural Economy, Parks Road, Oxford	Chemistry—G. R. Clarke, B.A., B.Sc., A.I.C. Economics—A. Bridges, B.A. Entomology—N. F. Cunliffe, M.A. Mycology—R. Woodward, B.Sc., Ph.D.
<b>6. South East Province.</b> Kent Surrey Sussex, East Sussex, West	South Eastern Agricultural College, Wye, Kent	Chemistry,—Wm. Goodwin M.Sc., Ph.D. Dairy Bacteriology—H. Barkworth. Economics—J. Wyllie, B.Sc., N.D.A. Entomology—F. V. Theobald, M.A., F.E.S. Mycology—Prof. E. S. Salmon, F.L.S.
<b>7. Southern Province.</b> Berkshire Buckingham Dorset Hampshire Isle of Wight Middlesex	University College, Reading	Chemistry—H. H. Nicholson, M.A., N.D.A. Dairy Bacteriology—L. J. Meanwell, N.D.D. Economics—Vacant. Entomology—F. O. Mosley, F.L.S. Mycology—W. Buddin, M.A.
<b>8. South West Province.</b> Cornwall Devon Isles of Scilly	Seale Hayne Agricultural College, Newton Abbot, Devon	Chemistry—A. Blenkinsop, B.Sc. Dairy Bacteriology—C. D. Oxley, N.D.A., N.D.D. Economics—W. H. Long, B.A. Entomology—W. E. Hodson, A.R.C.S. Mycology—A. Beaumont, B.A.
<b>9. Western Province.</b> Gloucester Hereford Somerset Wiltshire Worcester	Bristol University Agricultural Advisory Department	Chemistry — J. A. Hanley, Ph.D., A.R.C.S. (Chief Agricultural Advisory Officer). Chemistry—A. W. Ling, N.D.A. Dairy Bacteriology—C. A. MacEacharn, B.Sc. Economics—E. P. Weller. Entomology—L. N. Staniland, A.R.C.S. Mycology — R. M. Nattrass, B.Sc., Ph.D.

Advisory Areas.	Advisory Centre.	Specialist Advisory Officers.
10. <i>West Midland Province</i> Salop Stafford Warwick	Harper Adams Agricultural College, Newport, Salop	Chemistry—W. M. Davies, B.A., B.Sc., A.I.C. Dairy Bacteriology—E. L. Crossley, B.Sc., A.I.C. Economics—F. S. Dennis. Entomology—S. G. Jary, B.A. Mycology—Norman C. Preston, B.Sc.
11. <i>North West Province</i> . Cheshire Lancashire	Manchester University Agricultural Advisory Department	Chemistry—A. M. Smith, Ph.D., A.I.C. Economics—J. Orr, M.A. (Chief Agricultural Advisory Officer). Entomology—H. W. Miles, B.Sc. Mycology—E. Holmes Smith, B.Sc.
	Liverpool University, Department of Veterinary Pathology	Veterinary Science—K. D. Downham, B.V.Sc., M.R.C.V.S., D.V.H. (Prof. S. H. Gaiger, F.R.C.V.S., Head of Department.)
12. <i>North Wales Province</i> . Anglesey Carnarvon Denbigh Flint	University College of North Wales, Bangor	Chemistry—Prof. G. W. Robinson, M.A. Dairy Bacteriology—Miss P. M. Hickson, N.D.D. Economics* Entomology—Vacant. Mycology—T. Whitehead, Ph.D., M.Sc., A.R.C.S. Veterinary Science—R. F. Mont- gomery, B.Sc., F.R.C.V.S.
13. <i>Mid-Wales Province</i> . Brecon and Radnor Cardigan Carmarthen Merioneth Montgomery Pembroke	University College of Wales, Aberyst- wyth	Chemistry—T. W. Fagan, M.A., F.I.C. Dairy Bacteriology—S. B. Thomas, M.Sc. Economics*—A. W. Ashby, M.A. Entomology—J. R. W. Jenkins, B.Sc. Mycology—D. W. Davies, B.Sc.

Advisory Areas.	Advisory Centre.	Specialist Advisory Officers.
14. <i>South Wales Province.</i>	Glamorgan Monmouth	University College of South Wales and Monmouth, Cathays Park, Cardiff
15. <i>Edinburgh Province.</i>	Berwick Clackmannan Edinburgh Forfar Fife Haddington Kinross Linlithgow Peebles Perth Roxburgh Selkirk	East of Scotland College of Agriculture, 13, George Square, Edinburgh
16. <i>Glasgow Province.</i>	Argyl Ayr Bute Dumbarton Dumfries Kirkcudbright Lanark Renfrew Stirling Wigtown	West of Scotland Agricultural College, 6, Blythswood Square, Glasgow
17. <i>Aberdeen Province.</i>	Aberdeen Banff Caithness Elgin Inverness Kincardine Nairn Ross and Cromarty Sutherland	North of Scotland College of Agriculture, Marischal College, Aberdeen

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